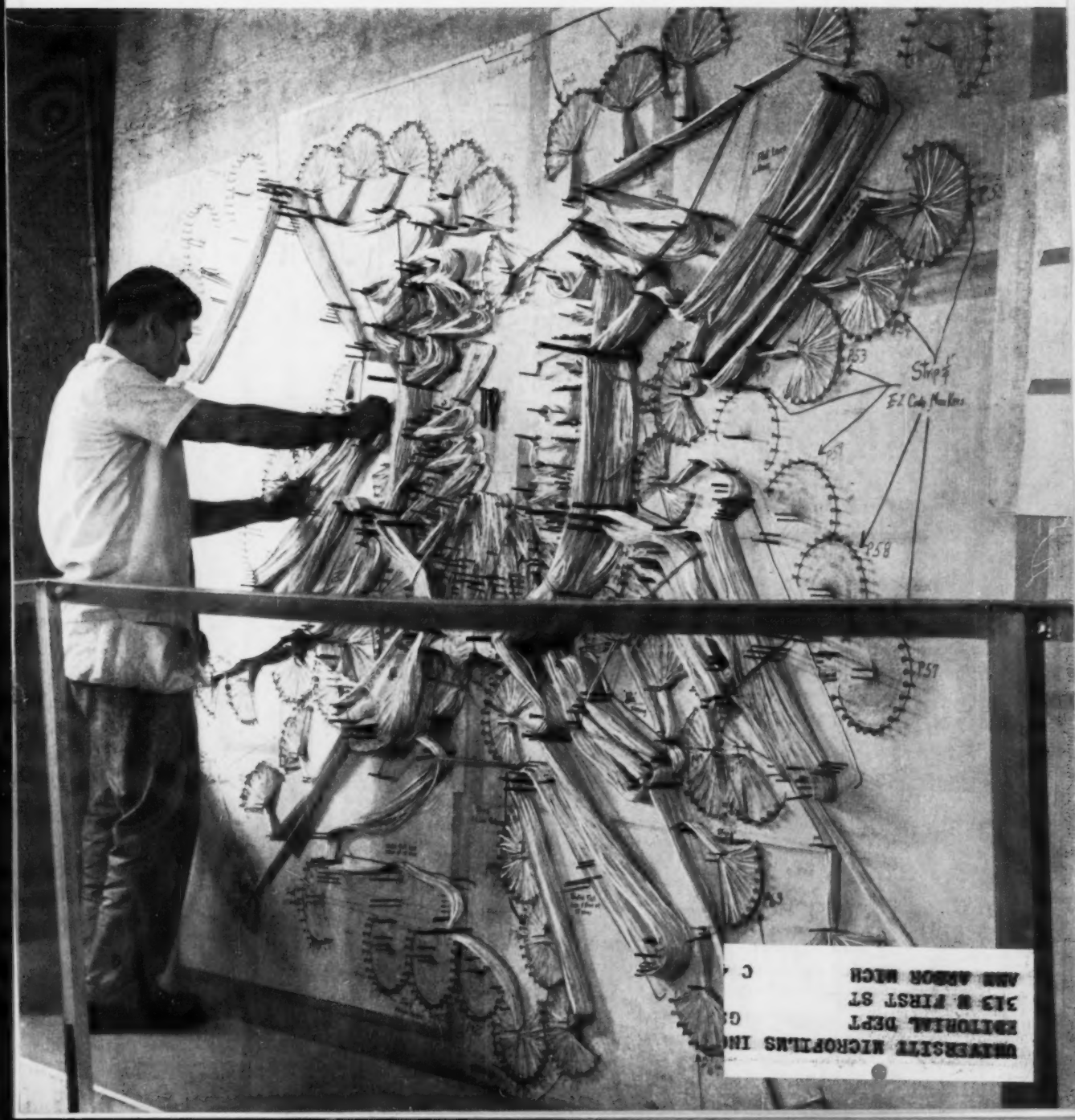
October 7, 1960

electronics

Worker mounts scaffold to build wiring harness for a nuclear submarine sonar system. Work table built into big harnessing board is another time-saving production technique shown on p 84

A McGraw-Hill Publication 75 Cents



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The bulk of UTC production is on special units designed to specific customers' needs. Illustrated below are some typical units and some unusual units as manufactured for special applications. We would be pleased to advise and quote to your special requirements.

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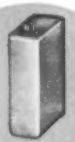
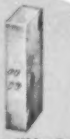


400 ∼ telemetering, 3 db at ± 7.5%, 40 db at 230 and 700 ∼, ⅝ x 1¼ x 2"

15 — BP filter, 20 db at 30 ∼, 45 db at 100 ∼, phase angle at CF less than 3° from —40 to +100°C.



LP filter within 1 db to 49 KC, stable to .1 db from 0 to 85°C., 45 db at 55 KC.

LP filter less than .1 db 0 to 2.5 KC, 50 db beyond 3 KC.

PULSE TRANSFORMERS

From miniature blocking oscillator to 10 megawatt.

Wound core unit .01 micro-second rise time.

Pulse current transformer 100 Amp.

Pulse output to magnatron, bifilar filament.

Precise wave shape pulse output, 2500 V. 3 Amps.

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Tuned DO-T servo amplifier transformer, 400 ∼ .5% distortion.

Toroid for printed circuit, Q of 90 at 15 KC.

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HVC tapped variable inductor for 3 KC oscillator.

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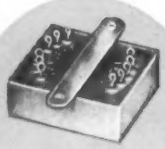
Saturable reactors, reference transformers, magnetic amplifiers, combined unit.

RF saturable inductor for sweep from 17 MC to 21 MC.



Voltage reference transformer .05% accuracy.

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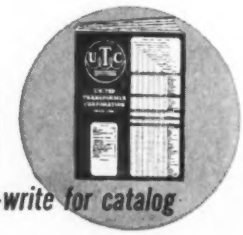

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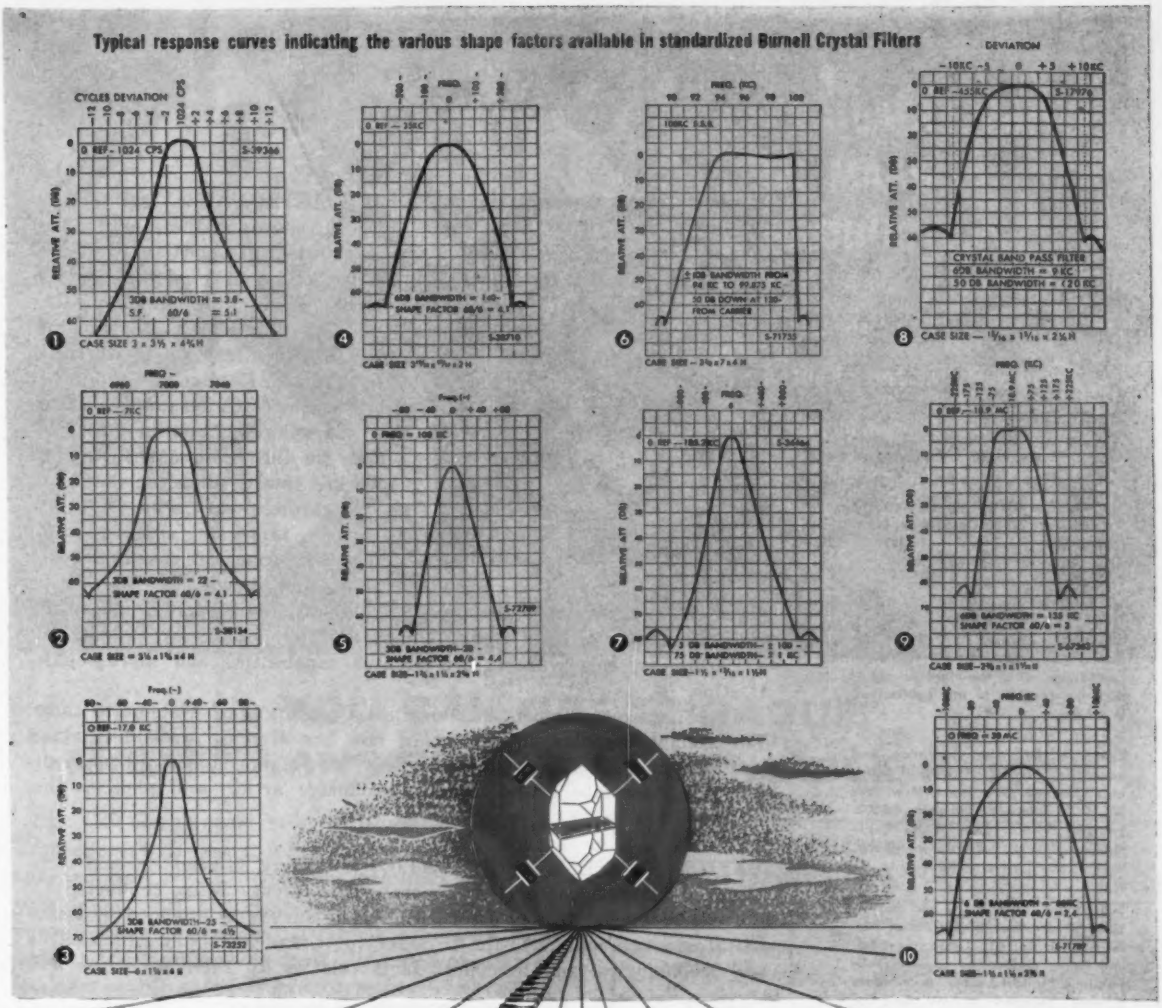
Typical response curves indicating the various shape factors available in standardized Burnell Crystal Filters



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CROSSTALK

electronics

Oct. 7, 1960 Volume 33 Number 41

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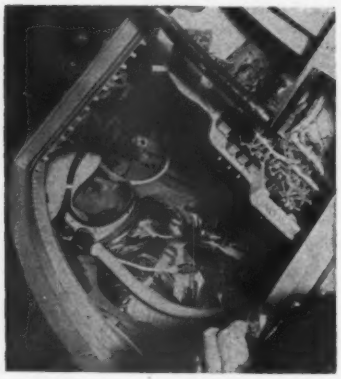

U. S. ASTRONAUT Virgil Grissom (left), shown in the Mercury capsule trainer at Cape Canaveral, Fla., may be the first man to go into orbit. Any of the other six astronauts might also be first. However, the first man may not be American at all, but a Russian.

The Soviet Union saw the propaganda value of "man-in-space" before we did. Consequently they've worked toward that goal longer.

Regardless of who is first, Mercury is a going concern. It is the first American manned space effort and it will be followed by many more. Design and construction of the Mercury system will be finished 18 months after it began. This in itself is a major accomplishment.

Future systems will require greater capabilities and more sophistication.

The Mercury system is in one sense a prototype of systems to come. For a comprehensive description of how the Mercury ground tracking and communications system works, and how later systems will be modified, see Associate Editor Mason's exclusive article and photographs, beginning on p 30.

NATIONAL SCIENCE FOUNDATION is urging all scientific and technical information centers to cooperate in a survey being conducted by Battelle Memorial Institute for NSF. The survey is intended to locate all information centers in the U. S. serving the physical and life sciences and technologies, and to collect facts relating to their activities and services.

Survey results will be used to prepare a national directory of information centers and "to relate the activities of the centers to the total U. S. scientific and technical information program."

Information on location, subject coverage, scope of collection, types of services available and so forth, will be gathered by questionnaire. NSF would like any information center to send its name and address to W. H. Bickley at Battelle, 505 King Ave., Columbus 1, O.

Coming In Our October 14 Issue

CRYOGENICS. At least two avenues of research are being pursued by computermen in their push toward higher speeds—microwave components (ELECTRONICS, p 77, Nov. 20, 1959) and cryogenics. The interest in cryogenics is based upon the development of superconducting devices such as the thin-film cryotron (ELECTRONICS, p 39, April 17, 1959, and p 55, Jan. 29, 1960). These devices give promise of high-speed switching and storage capabilities in computers of reduced size.

In our next issue, D. R. Young of the IBM Research Laboratory in Poughkeepsie, N. Y., reviews the principles of superconducting devices and shows how they can be used to form actual computer circuits. You'll learn about the operation of the thin-film cryotron and some of the problems in designing cryotron switching and storage circuits. Young's article also describes some of the latest cryotron construction techniques.

AVAILABLE NOW IN MASS PRODUCTION

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YOU CAN GET SPRAGUE* MADT® TRANSISTORS AT SENSIBLE PRICES

Sprague Germanium Micro-Alloy Diffused-Base Transistors, well-known for their rugged vhf performance, are now *priced below other transistors* with comparable electrical characteristics. In many areas, this permits designers to improve circuit techniques without necessarily increasing costs. Expanded production facilities enable us to *ship quantity orders on short notice.* Add to this their *ultra-fast switching time,* and you have three good reasons why Sprague MADT® Transistors have achieved their high level of acceptance.

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Type	**Application**
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2N501	Ultra High Speed Switch (Storage Temperature, 85 C)
2N501A	Ultra High Speed Switch (Storage Temperature, 100 C)
2N504	High Gain IF Amplifier
2N588	Oscillator, Amplifier, to 50 mcs

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Metronix offers two such instruments: Model 300-1 for DC measurements and Model 311-1 for AC measurements.

Model 311-1

These instruments, like all Metronix PMEV's, also offer these familiar advantages:

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COMMENT

Electronics Probes Nature

May I congratulate the editors of ELECTRONICS on the comprehensive and clear coverage of the field of electronics in your article "Electronics Probes Nature" (p 53, July 29)? I was happy to contribute to this, but I did not expect that when I read it I would find the other articles more interesting to me than my own contribution. This is, you understand, an unusual experience for an author.

I am hoping to use reprints of your article in some of my classes. . .

CHARLES H. HAPGOOD
KEENE TEACHERS COLLEGE
KEENE, N. H.

. . . I think you have done an excellent job with this report and that you are indeed to be congratulated.

First of all, I am quite impressed with the idea of the report itself. I feel that all too often important and glamorous military and industrial applications of electronics are emphasized to such a point that the valuable contributions electronics is making in man's understanding of the universe are overlooked.

I am sure that it must have been a gigantic task to even gather the material and I am somewhat amazed that you could put so much information in such usable form into such a relatively small space. I can assure you that we are delighted to have Varian included in such a fine report. . .

P. MCKIBBEN
VARIAN ASSOCIATES
PALO ALTO, CALIF.

Heat Sink Calculations

The article appearing in the Aug. 5 issue of ELECTRONICS on "Transistor Heat Sink Calculations" (p 66) references a graph from the "Motorola Silicon Zener Diode Handbook." This graph is taken from the Motorola applications note number 3 "Temperature Control of Power Transistors," and plots heat-sink area as thermal resistance. For bright aluminum, the equation $\theta = 32.6A^{-.472}$ was determined experimentally for a particular transistor mounted on a specific heat sink operating under special conditions. Motorola cautions "any equation or curve is a specific example and does not necessarily apply to another specific problem."

Rule-of-thumb equations for the relationship of area to thermal resistance for bright aluminum are $\theta = 238A^{-1}$ deg C/W; $\theta = 250A^{-0.93}$ and $205A^{-0.97}$. When plotted, all of these equations are very close. Transitron's Forced-Air Rectifier Cooling Curve for free air is the equation $\theta = 250A^{-0.95}$. Since the results of calculations using these equations are theoretical, they should serve only as estimates. Power, temperature level and mounting conditions enter into the effects of the heat sink. Actual tests should be run under worst foreseeable conditions to determine the temperatures.

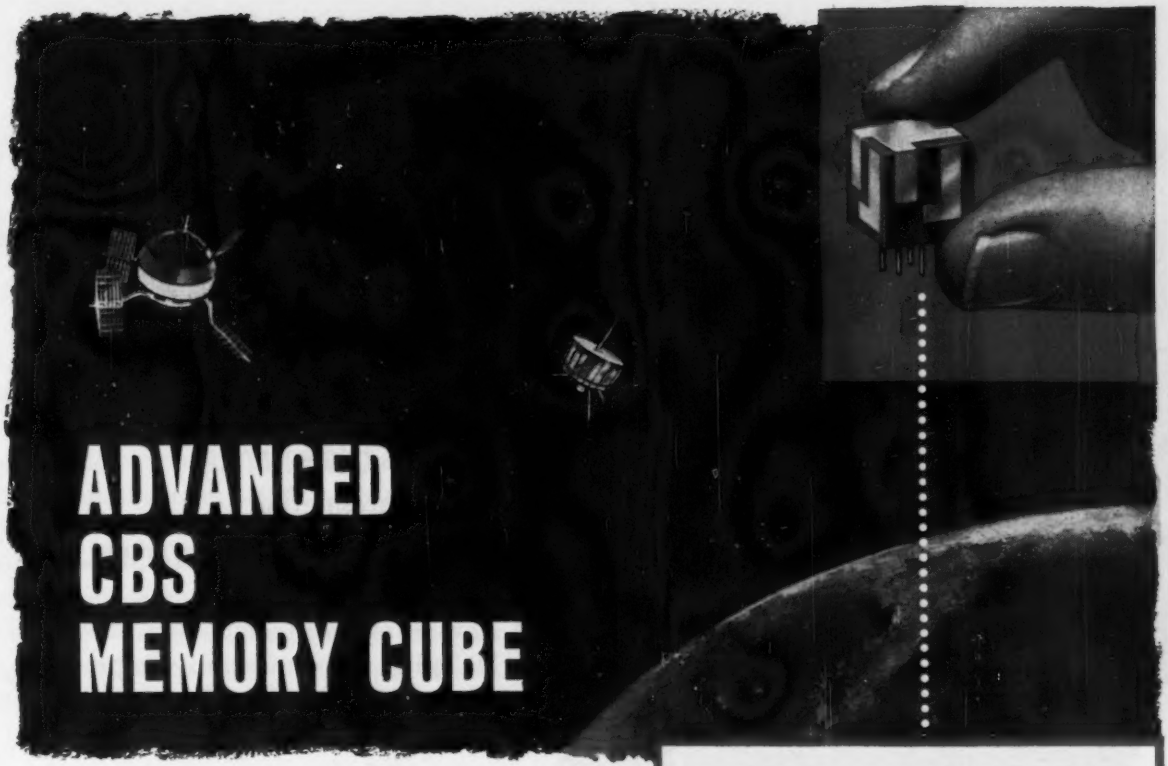
I bring this up because the calculation in the article used the maximum rating for the junction temperature of the transistors, leaving no derating for reliability for those transistors with the highest dissipation. If the heat sink designed is inadequate, the maximum junction temperatures of the transistors would be exceeded . . .

ARON HOFFMAN
PHILCO CORP.
PHILADELPHIA

Author Greenbaum replies:

(Reader Hoffman is) quite right in questioning the use of the maximum junction temperature in the illustrative example. As pointed out in the article, a safe value of junction temperature for each transistor should be selected. This temperature will be less than the maximum junction temperature for the particular transistor. It should be noted, however, that the use of 85 C as the junction temperature is quite safe considering that there are many germanium transistors available with maximum junction temperatures of 85 C and 100 C.

MYRON GREENBAUM
POLARAD ELECTRONICS
LONG ISLAND CITY, N. Y.



ADVANCED CBS MEMORY CUBE

Now available for evaluation

For customer evaluation, CBS Electronics offers a working 16-bit *sample* memory cube. Its "new-concept" design features plastic-encapsulated ferrites and deposited conductors, resulting in compactness, light weight, and shock resistance never before achieved.

Check the features, unique construction and technical information. Order the CBS M-267 sample memory cube from stock . . . nominal charge $50.00. Evaluate for yourself, firsthand, the benefits of its advanced design.

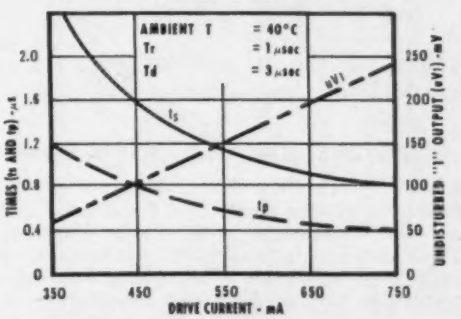
UNIQUE PACKAGING OFFERS MANY FEATURES

Miniaturization . . . techniques used result in significant reductions in volume and weight, with densities up to 2,000 bits per cubic inch. Conventional wiring frame and most hand wiring are eliminated.

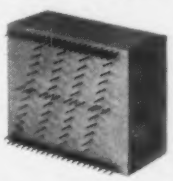
Uniformity . . . the "ONE" outputs of the 16 bits in the test cube reach amplitudes within ±5% of each other.

Environmental . . . improved temperature, humidity, shock and vibration characteristics are provided, yet encapsulation techniques employed have no adverse effects on the ferrites.

TYPICAL OPERATING CHARACTERISTICS CBS M-267 at 40°C



CUSTOMIZED SYSTEMS



After your evaluation of the M-267, CBS Electronics can supply development facilities for custom-designing memory systems for your military computer requirements. This typical CBS customized memory pack, a multi-aperture, nondestructively-sensed, word-organized system, achieves a density of 15,456 bits in less than 23 cubic inches. Other CBS custom designs include nondestructive readout memories and ferrite logic systems. The ferrite cores in the memories meet a wide range of requirements for signal output, switching time, and current drive.

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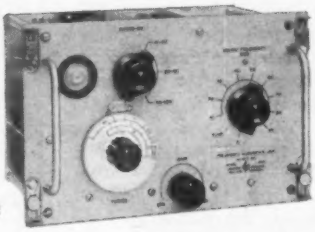
MEASURE to 500 MC - with

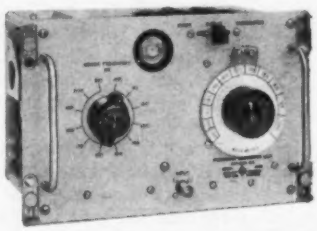
Simple operation with plug-ins—high sensitivity—ideal for telemetering, mobile, production, general purpose measurements

Now hp offers a completely new, 500 MC plug-in—materially improving the versatility and usefulness, as well

Still more versatility for 524 series counters!
Order the measuring capability you need now—later add other plug-ins to increase counter usefulness.



hp 525A Frequency Converter
$250.00, extends counter range to 100 MC



hp 525B Frequency Converter
$250.00, extends range to 220 MC

hp IS HEADQUARTERS FOR ELECTRONIC COUNTERS

Standard of the industry for frequency, period, phase and time interval measurement—accurate, dependable, versatile, economical!

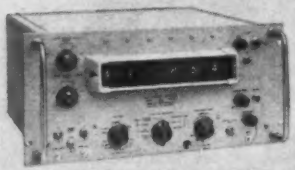
hp 524C/CR ELECTRONIC COUNTERS (shown above)

Measure to 10.1 MC individually, to 500 MC with plug-ins, to 18 KMC with external accessories*. The hp 524C/CR also measures time interval 1 μsec to 100 days or period 0 cps to 100 KC, automatically, directly, without tedious calculation or interpolation. Big, bright in-line readout. Maximum resolution 0.1 μsec; stability $3/10^8$ short term and $5/10^8$ per week. High sensitivity, high impedance, hp 524C (cabinet—shown above) $2,300.00; hp 524CR (rack mount) $2,275.00.

hp 524D/DR Electronic Counter

Offers electronic features identical to those of hp 524C/CR except that it has eight-place neon columnar readout. hp 524D (cabinet) $2,150.00; hp 524DR (rack mount) $2,125.00.

**with hp 540B Transfer Oscillator and hp P932A Waveguide Mixer*



hp 523CR ELECTRONIC COUNTER

10 cps to 1.2 MC with new 0.1 v sensitivity. Bright in-line readout. Measures time interval 1 μsec to 10^6 sec and period 0.00001 cps to 100 KC and phase angle. Stability $2/10^6$ per week. Improved circuitry prevents triggering by unwanted signals, noise. Results appear in seconds, msec, μsec or KC with automatic decimal. hp 523CR (rack mount) $1,485.00.

hp 523DR Electronic Counter

Offers electronic features identical with those of hp 523CR but has six-place neon columnar readout. hp 523DR (rack mount) $1,285.00.

COUNTER ACCURACY!

as frequency range, of popular hp 524 series 10 MC electronic counters.

Combined with the hp 524C 10 MC counter, for example, the 525C plug-in offers measurement with high sensitivity to 500 MC yet retains measurement accuracy and even increases resolution at high frequencies. Also preserved are 524C measuring ease, digital recorder output capability and its big, bright in-line display.

Specifications hp 525C

Range: Counter converter, 100 to 500 MC; counter amplifier, 50 KC to 10.1 MC. Direct connection for 0 to 10.1 MC.

Accuracy: Retains accuracy of 524 Counter.

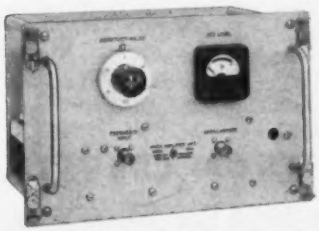
Registration: 9 places, 1st two on converter dial, next 7 displayed by counter.

Input Voltage: 20 mv rms min., 50 KC to 10.1 MC; 100 mv rms min., 100 to 500 MC.

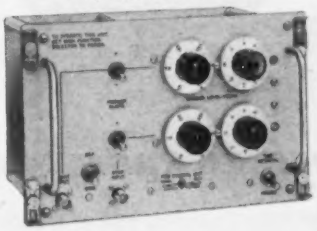
Input Impedance: Approx. 700 ohms, 100 to 500 MC.

Price: hp 525C, $425.00.

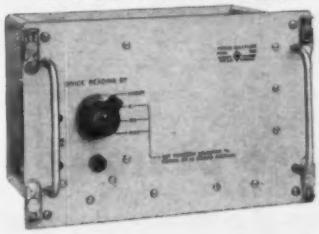
hp 526A Video Amplifier
$175.00, increases sensitivity to 10 mv



hp 526B Time Interval Unit
$175.00, for time interval measurement 1 μsec to 10^7 sec.



hp 526C Period Multiplier
$225.00, increases period measuring accuracy with 100, 1,000, 10,000 cycle multiples



hp 522B/BR ELECTRONIC COUNTER

Popular hp 522B/BR measures frequency 10 cps to 120 KC, period 0.00001 cps to 10 KC, time interval 10 μsec to 10^5 sec. Reads direct in cps, KC, seconds, milliseconds. Time base stability $1/10^5$ per week; counts automatically, resets, action repetitive. Applications include measurement of production line quantities, nuclear radiation, power line frequencies, very low frequencies, and, with transducers, a wide array of physical quantities and phenomena. hp 522B (cabinet) $915.00; hp 522BR (rack mount) $900.00.

hp 521 INDUSTRIAL COUNTERS

hp offers five Model 521 counters, all useful in measuring frequency, random events per unit of time, and, with transducers, speed, rps, rpm, weight, pressure, temperature, etc. Direct readings, display time variable or "hold"; four instruments cover frequency range 1 cps to 120 KC; the fifth measures to 1.2 MC. Two models with big, bright, in-line numeric readout, three with columnar neon display. Prices, $475.00 to $875.00. Cabinet and rack mounts available.

Data subject to change without notice. Prices f.o.b. factory.

See your nearest hp representative or write direct for information, demonstration of any hp electronic counter.

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ADVANCED DESIGN POWER TRANSISTORS FROM CLEVITE

Three new lines of germanium power transistors by Clevite feature new advances in controlled gain spread, fully specified collector-to-emitter voltage characteristics and low current leakage — even at maximum voltages and high temperatures.

The new 8 ampere switching series can be used to replace the older, more costly ring-emitter types in 3 to 8 ampere service.

The new 25 ampere switching type offers exceptionally low saturation voltage and is available with either pin terminals or solder lugs.

The new Spacesaver design not only affords important savings in space and weight, but its significantly improved frequency response means higher audio fidelity, faster switching and better performance in regulated power supply applications. Its low base resistance gives lower input impedance for equal power gain and lower saturation resistance, resulting in lower "switched-on" voltage drop. Lower cut off current results in better temperature stability in direct coupled circuits and a higher "switched-off" impedance.

CLEVITE NOW OFFERS THESE COMPLETE LINES

Switching Types	Amplifier Types
5 ampere	2 watt
8 ampere	4 watt
15 ampere	
25 ampere	2 watt Spacesaver
3 ampere Spacesaver	

All Clevite germanium power transistors are designed for low thermal resistance, low base input voltage, low saturation voltage and superior current gain.

For latest data and prices or application assistance, write for Bulletin 60 . . .

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CLEVITE TRANSISTOR

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ELECTRONICS NEWSLETTER

Soviets May Launch Mars Probe Soon

SOVIET UNION may be planning to loft a space probe to Mars any day now. The present period is the most favorable for such a try (Oct. 1 was the best date). Another such period will not occur until Nov. 16, 1962. The astronomical conditions will continue approximately through October.

Scientists at National Aeronautics & Space Administration admit they wouldn't be surprised if the Soviets made the attempt; the USSR has already demonstrated that its rocket capability is adequate for such a shot, NASA says.

Possibility is reinforced by an article in Moscow's *Economic Gazette* last week in which space expert G. Pokrofski discussed the problems currently facing Soviet scientists in planning a spaceflight to Mars or Venus. He said that the principal obstacle is radio apparatus small enough and powerful enough to provide reliable communications between the earth and the probe.

Pokrofski went on to say that automatic devices will precede man into space, adding "it is already possible in principle to send an automated station to the vicinity of Mars or Venus and send back better photographs than were taken of the Moon's reverse side."

Meanwhile, Vladimir Timakov of the Soviet Medical Academy disclosed that a would-be astronaut is undergoing training in the Soviet Union. Only one candidate was mentioned (the U. S. is training seven); he is a spare citizen of less than medium stature, probably a jet pilot.

Microwave Relays Control Swiss Radars

MICROWAVE RELAY LINKS are being installed at two Swiss airports to permit remote control and monitoring of air-route surveillance radars. Operators will be able to control and monitor more than 70 radar functions with a time lag of less than 0.1 sec.

The radars were produced by Raytheon for Radio Suisse S.A., will be operated from control centers at the Geneva-Cointrin and Zurich-Kloten airports. Raytheon Canada will install radar transmitters and receivers for Geneva-Cointrin atop 5,000-ft Mt. LaDole, 16 miles away from the airport site. For Zurich-Kloten, a concrete structure 60 ft high will be built on a hill seven miles distant. Range of the 4,000-Kw sets at Geneva-Cointrin will be in excess of 200 miles for large craft, 160 miles for the smaller jets.

Control system uses an encoder-decoder that is both signal converter and memory device. D-c signals resulting from switch positioning at the operator's panel are converted into a telegraph code. Coded messages are transmitted to the radar site, reconverted into operational voltages. These voltages activate the relays whose contacts repeat the positions of the originating switch, thus controlling radar operations. Memory capability permits the encoder-decoder to accept a series of signals from the operator, execute them in sequence according to operational priority.

Optical Sensor Reads 480 Numerals a Second

OPTICAL CHARACTER READER has been developed by IBM to work into its 1401 computer. The sensor can read the ten numerals and three special characters as produced in the IBM 407 type font. This font is used by IBM's model 407, 308 and 409 accounting machines, 1403 printer, or electric typewriter equipped with the right typebars. The reader can also handle the elongated 407 font (seven rather than ten characters to the inch), which is used by many credit-card imprinters; or it can be equipped for mark-reading.

The model 1418 reader converts the numerical data into machine code, feeds it to the magnetic-core storage of the 1401. It can at the same time sort the documents.

The 1418 handles one size of document at a time, can be adjusted to handle documents in the range 2¾ in. by 5¾ in. to 3¾ in. by 8¾ in., from 0.0035 in. to 0.007 in. thick. It reads up to 480 characters a second from any given line on the document. Only one fixed line can be read by a reading head, of which the machine may have as many as two. Machine speed is up to 400 documents a minute depending on the width of the documents and the number of characters to be read. The 1401 program controls the number of characters sensed by each head and switches, if necessary, from head to head.

Service Firm to Buy Giant-Sized Computer

COMPUTER SERVICE BUREAU C-E-I-R of Arlington, Va., will install a giant IBM Stretch system in 1962 in its Los Angeles Research Center. The Stretch, which is said by IBM to be 15 times faster than the IBM709, will be able to execute about 2 million instructions a second, up to 75 billion computations in a day. C-E-I-R plans to use it for all sorts of problems, ranging from aerodynamic design computations to stock margin calls.

The system's program-interrupt feature will permit the machine to put aside a long, low-priority job to handle a special task that requires immediate attention. C-E-I-R figures that the computer can be tied into clients' offices and plants, and to other company-owned research centers, by data link.

High-Pressure Research Continues on Materials

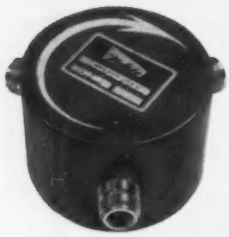
STUDY OF ELECTRONIC materials under high pressures got an added boost last week as MIT's Lincoln Laboratory solid-state division set up experiments with a tetrahedral press which will create pressures of 3.5 million psi. Pressure will be maximized, flexibility minimized. Subjects for research will include insulators, dielectrics, magnetic materials and semiconductors. Goals are to synthesize new materials, find out what happens to defects structure of normally grown materials when subjected to extreme pressures, measure changes in electrical properties and observe solid-state transformations.

Advanced microwave

COMPONENTS from MELABS

seasoned microwave designers and builders

NEW! L Band and 400 MC Circulators



Model X-101A, L Band

Lightweight, compact 3-port circulators, 10% bandwidths. Conveniently separates input, output terminals of parametric amplifier to increase gain-bandwidth and stability.

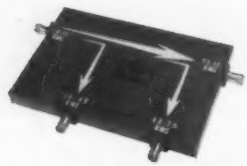
Model X-127, 400 MC

SPECIFICATIONS

Other models available with similar characteristics from 360 to 3000 MC; also tunable units to cover 25% bandwidth. Can also be supplied with electromagnet for high speed switching applications.

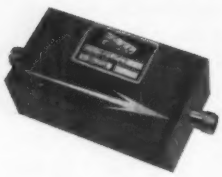
	Model X-101A	Model X-127
Frequency—fixed tuned:	1300 to 1500 MC	380 to 420 MC
Insertion loss:	1 db max.	1 db max.
at band center:	0.5 db max.	0.5 db max.
Isolation:	15 db min.	17 db min.
at band center:	20 db min.	24 db min.
VSWR:	1.3:1	1.3:1
at band center:	1.1:1	1.1:1
Size, including connectors:	3½" diam.	5½" diam.
Weight, approx.:	2 lbs.	4 lbs.
Price:	$400.00	$400.00

UNIQUE! Band separation filters. Models X-121/122/123 three-port filters can separate the 1 to 12 KMC spectrum into octave bands. They permit two or more broadband receivers to be connected to a single very broadband antenna with a minimum insertion loss and high isolation between receivers. Two or more of the models can be combined as shown in the photo.



	Model X-121	Model X-122	Model X-123
Input frequency range	1 to 12 KMC	4 to 12 KMC	1 to 4 KMC
Output frequency ranges:	1 to 4 KMC 4 to 12 KMC	4 to 7.5 KMC 7.5 to 12 KMC	1 to 2 KMC 2 to 4 KMC

PLUS these precision microwave components:



Melabs isolators include millimeter wave ferrite models, 66 to 73 KMC; miniaturized ferrite S-band isolators (only 3½" long, including connectors), 2,700 to 3,100 MC; resonance absorption radiometer and telemetry band devices, 1,330 to 2,360 MCS; broadband load isolators covering, collectively, 3.95 to 40.0 KMC without tuning.

Melabs directional couplers provide uniform coupling over a 2:1 frequency range, are available for frequencies from 0.5 to 8.0 KMC, can be built to your specification on special order.

Melabs untuned broadband coaxial mixer Model M-3 with high conversion efficiencies covers 0.5 to 11 KMC. Melabs also offers blockers designed for dc and low frequency isolation of both inner and outer conductors.

Write today for information on these and other Melabs microwave components.

Data subject to change without notice. Prices f.o.b. factory.

Employment opportunities at Melabs are exceptional for ambitious engineers and physicists. Write in confidence.

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PRODUCES TOTAL RELIABILITY

Infinitesimal Mechanical Variation due to *Exclusive* Automation Processes

***plus* *Exclusive* Glass Alkyd Molded Permanence**

***plus* *Exclusive* Full Silver Coverage on Contact Surface**

***equals* NEW CTS NON-DRIFT COMPACT SELECTOR SWITCHES**

Formerly manufactured by Trolex Corporation, now a part of CTS. 1⅛" diameter 12-position indexed rotary switches are designed primarily for low power exacting military and commercial RF, VHF and UHF circuit applications. Series 212 surpasses MIL standards.

UNPRECEDENTED SWITCH UNIFORMITY FROM ENTIRELY NEW AUTOMATED MANUFACTURING CONCEPT

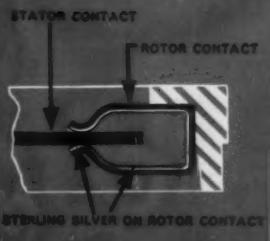
- Drift virtually eliminated by molding terminals into exact, immovable, permanent position in stator, entirely by machine . . . making all switches identical in each production run. Machine exactitude replaces human error and variations, eliminating the wider tolerances characteristic of hand assembly.
- Delicate switch parts are not exposed to breakage; many parts are not even handled.
- Superior insulation due to repetitive exactness in terminal spacing and molded glass alkyd material.
- Heat from soldering cannot loosen terminals.
- Natural design barrier prevents solder from flowing into circuit elements during soldering.

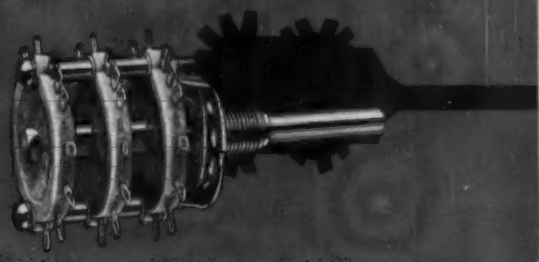
SAFER, QUICKER, EASIER HANDLING IN YOUR PRODUCTION LINE

Molded glass alkyd stator won't break or crush during ordinary handling or if accidentally dropped. Terminals cannot be dislodged or moved. Both stationary and movable contacts are enclosed for additional safety and handling convenience.

LONGER LIFE CONTACTS

- After 1,200,000 index operations, life tests reveal virtually no change in rotor contact resistance.
- 1000% *more* silver than used by most commercial switches has been *evenly* applied at actual point of contact by exclusive process. (See Sketch). Optional solid sterling silver contacts and stator available for additional contact performance.
- Rotor contacts are double-wiping and self-cleaning.
- Stator contacts are integral with terminals.



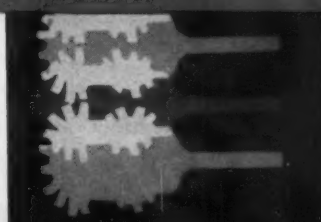


NOW! NEWLY TOOLED CLUSTER AND 3-FINGER CONTACTS

Offered for numerous additional circuits not previously available. Tremendous range of options meet most requirements without special tooling.

OTHER FEATURES

- Series 212 is available in numerous combinations with CTS variable resistors and power snap switches.
- Condensed assembly. Wafers can be stacked adjacent to each other. No spacers required.
- Non-toxic combustion fumes—an important advantage in submarine or similar closed space applications.
- Exclusive balanced detent mechanism has 2 dissimilar detent forms for definite feel and long pull in.
- New balanced lever arm and star wheel detent assembly free from end and side thrust for extremely long life and accurately controlled torque. Optional at extra cost.



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CTS *Corporation*

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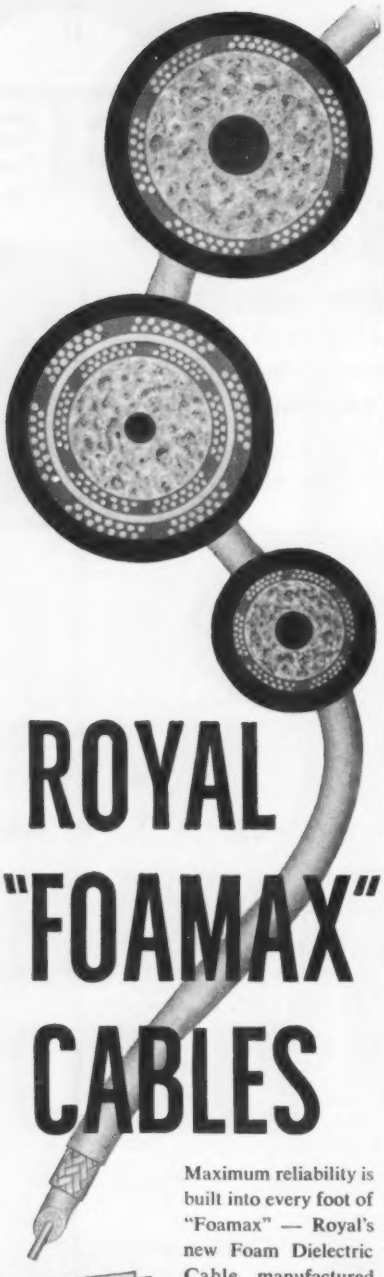

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WASHINGTON OUTLOOK

DEFENSE DEPARTMENT is pushing plans to beef up the nation's satellite detection system.

Two sets of three stations each now watch the skies for satellites. Each consists of a radar transmitter and two receiving stations. One is centered at Gila River, Ariz., with its western ear at San Diego, Calif. The other transmitter is at Jordon Lake, Miss., with its eastern ear at Ft. Stewart, Ga. The result is a transcontinental fence—with a gap in the middle: each trio of stations can cover a 500-mile front, can detect satellites with reasonable certainty only if they're less than 500 miles up.

A new high-powered transmitter is slated for installation near Wichita Falls, Tex., to plug the gap in the fence. It will be considerably more powerful than the two existing transmitters, but the Pentagon won't say how much farther out the new radar will be able to see. The other transmitters are also likely to be replaced by more powerful units soon.

A north-south fence is also under consideration. Space experts differ on the need for such a facility. Theoretically, the east-west fence will detect any satellite launched above 32 deg N, which would include Soviet launchings. But a north-south fence could materially reduce detection time.

NAVY is taking its fight against unification of the services to industry, spelling out its views in terms of dollars and cents to contractors.

The pitch is this: increased unification of the services would mean consolidation of procurement and centralization of research and development. This, the Navy says, could result in reducing the number of defense contractors.

When each of the services buys its own goods or contracts for its own R&D, Navy's argument goes, each service can go to as many companies as it chooses. If just one agency handles all contracting, it will naturally cut the number of suppliers.

Navy has long opposed the Pentagon pressure towards greater unification, which to the admirals means a downgrading of the naval role. Political platforms of both parties have heightened the Navy's fears. Both platforms mention a need for defense reorganization leading to more unified control.

Navy is particularly worried about the Democrat intentions, since Sen. Stuart Symington (D., Mo.)—a former Air Force Secretary and a long-time advocate of unification—is a key advisor on defense matters to the Kennedy camp.

TOP-BRACKET BRITISH ECONOMIST Geoffrey Browne has given Washington his assessment of the long-range impact of European economic integration on U. S. business.

His view is that Europe's economic boom and internal trade rivalries are a mixed blessing for U. S. exports and U. S.-owned plants overseas. He cites electronics as one area in which U. S. producers and exporters will be faced with stiffer competition as a result of economic integration.

Browne says that technological advances on the continent will result in substantially increased competition between European enterprise and U. S. producers in Europe, in third markets such as Latin America and Asia, and within the U. S. market as well.

NATIONAL AERONAUTICS & SPACE ADMINISTRATION is designing a "standard" space vehicle—both satellite and launcher—which could perform a wide variety of scientific experiments and eliminate custom-tailoring.

Most of the fabrication work is being done in-house by the agency. The satellite is expected to be ready in another year or so. NASA's plan is to standardize all equipment needed for lofting the satellite and feeding back information.

Payloads for the standard satellite—dubbed the "space bus"—will run a ton or so. NASA officials figure it will allow them to cut time and cost, conduct space probes almost on a production-line basis. As scientists come up with proposals for experiments, the plans will be pooled with other experiments and scheduled on the next "bus."

π

3.14159265358979323846264338327950288419716939937510582097

symbol of precision

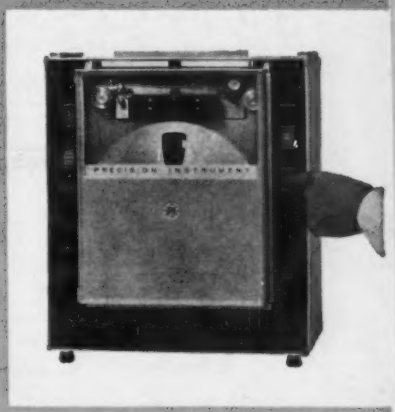
It's a simple matter for today's computer to extend the accuracy of the symbol π to a fantastic 10,000 decimal places and beyond, thanks to such advances as solid-state electronics. Thus the symbol π is a logical name for Precision's new all-solid-state instrumentation tape recorder, which has dramatically extended performance levels to literally *twice* those of ordinary magnetic tape instruments. The Precision π recorder offers:

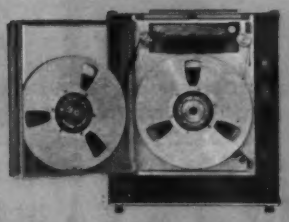
TWICE the frequency response previously obtainable with conventional recorders

TWICE the recording time for a given length of tape—as much data on a 10½ inch reel as previously on a 14 inch reel

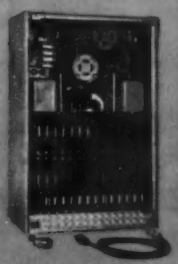
TWICE the economy, HIGHER reliability, LOWER flutter, LESS maintenance

Write for your copy of Bulletin 59, which describes the new Precision π Recorder, based on the thoroughly tested and field-proven design of the FIRST all-solid-state instrumentation tape recorder, the Precision PS-200 Series.





Open door view of 7-channel machine, showing loaded tape magazine which can be interchanged in 5 seconds.



Rear view of 14-channel recorder which weighs only 105 pounds, fits in only 26½ inches of rack space.

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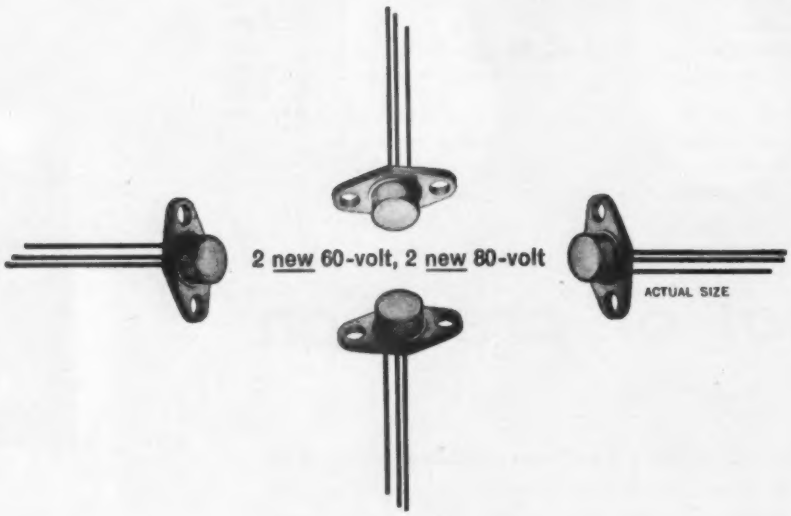
4 new miniature DELCO POWER TRANSISTORS



NOW, FROM DELCO RADIO, A COMPLETE LINE OF SMALL, HIGH-POWER TRANSISTORS!

	2N1172	2N1611	2N1612	2N1609	2N1610
V_{CB}	40	60	60	80	80
V_{EBO}	20	20	20	40	40
V_{CEO}	30	40	40	60	60
I_C	1.5 A	1.5 A	1.5 A	1.5 A	1.5 A
I_{CO}	200 μ a	100 μ a	100 μ a	100 μ a	100 μ a
H_{FE}	30/90	30/75	50/125	30/75	50/125
V_{Sat}	1.0 V	1.0 V	0.6 V	1.0 V	0.6 V

These four new Delco transistors, plus the 2N1172 40-volt model, offer highly reliable operation in a new range of applications where space and weight are restricting factors.

Designed primarily for driver applications, Delco's versatile new transistors are also excellent for amplifiers, voltage regulators, servo amplifiers, miniature power supplies, ultra-low frequency communications, citizens' radio equipment and other uses where substantial power output in a small package (TO 37) is required.

Special Features of Delco's Four New Transistors: Two gain ranges. Can be used on systems up to 24 volts. Can be mounted with the leads up or down with the same low thermal resistance of 10° C/W. Dissipation up to 2 watts at a mounting base temperature of 75° C.

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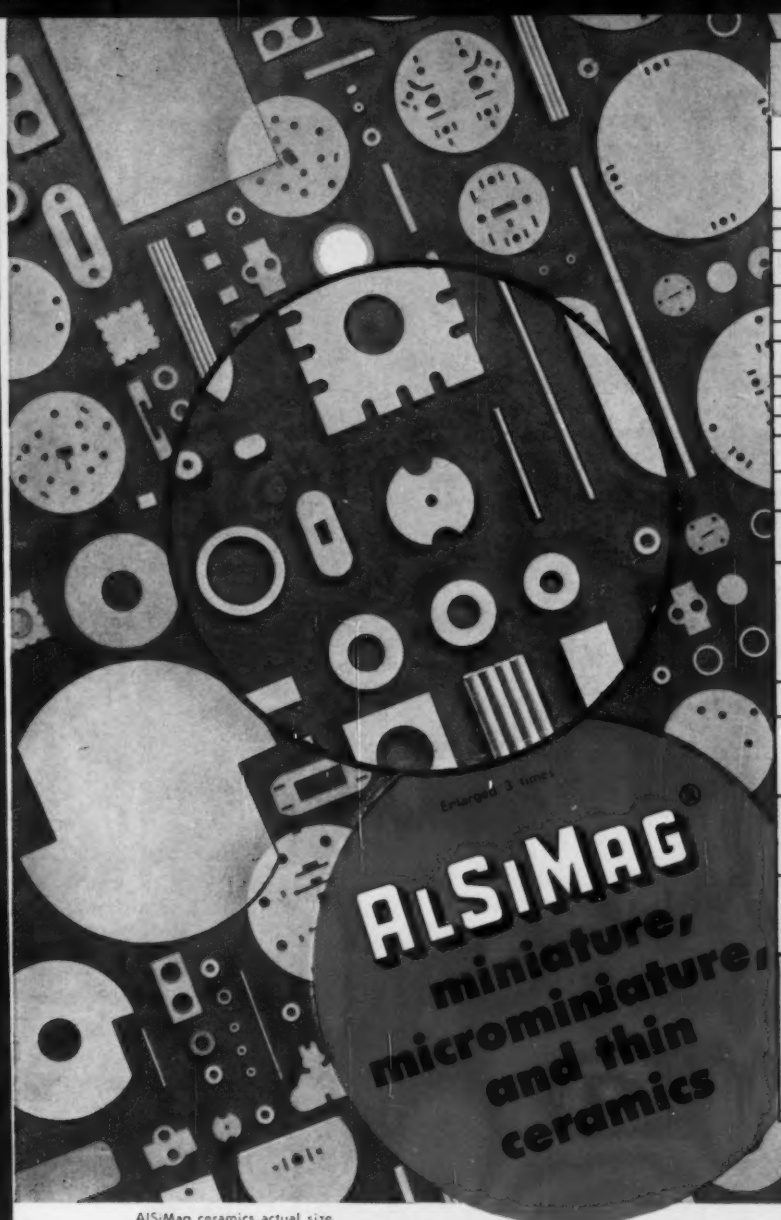
CIRCLE 16 ON READER SERVICE CARD

CIRCLE 17 ON READER SERVICE CARD→



AlSiMag ceramics actual size

Mechanical and Electrical Properties of AlSiMag Alumina Ceramics 393, 548, 614

PROPERTY		ALSIMAG 393	ALSIMAG 548	ALSIMAG 614
Water Absorption		12 to 18 Highly Porous	14 to 17 Highly Porous	0.00 Impervious
Specific Gravity		2.4	2.4	3.7
Density		.087	.087	0.135
Softening Temperature		1 800 3 272	2 030 3 722	1 650 3 002
Safe Temperature at Continuous Heat		1 400 2 552	1 600 2 912	1 550 2 822
Hardness		———	———	9
Thermal Expansion Linear Coefficient		6.0×10^{-6} 7.2×10^{-6}	6.9×10^{-6} 8.2×10^{-6}	6.5×10^{-6} 7.9×10^{-6}
Tensile Strength		———	———	25 000
Compressive Strength		30 000	10 500	400 000
Flexural Strength		10 000	8 000	60 000
Resistance to Impact (½" rod)		3.0	3.0	7.0
Thermal Conductivity (Approximate Values)		.004	.004	.045
Dielectric Strength (step 60 cycles) Test discs ¼" thick		50	50	230
Volume Resistivity at Various Temperatures	25°C.	$>10^{14}$	$>10^{14}$	$>10^{14}$
	100°C.	5.0×10^{12}	$>10^{14}$	2.0×10^{13}
	300°C.	1.0×10^{10}	$>10^{14}$	1.1×10^{10}
	500°C.	7.5×10^{7}	1.0×10^{10}	7.3×10^{7}
	700°C.	3.6×10^{6}	2.7×10^{8}	3.5×10^{6}
	900°C.	5.6×10^{5}	8.0×10^{6}	6.8×10^{5}
To Value		835 1 535	1 000 1 832	840 1 544
Dielectric Constant	60 Cycles	———	———	———
	1 MC.	5.5	5.5	9.3
	100 MC.	5.3	———	———
	10,000 MC.	———	———	9.1
Power Factor	60 Cycles	———	———	———
	1 MC.	.0005	.0005	.0003
	100 MC.	.0005	———	———
	10,000 MC.	———	———	.0014
Loss Factor	60 Cycles	———	———	———
	1 MC.	.003	.003	.0028
	100 MC.	.003	———	———
	10,000 MC.	———	———	.013

These are the most frequently used AlSiMag ceramic compositions for small or thin designs.

Other AlSiMag formulations are available to meet highly specialized requirements. For advice on such requirements give operating details.

AlSiMag pioneered the custom manufacture of ceramics for modules and for micromodules and has long been known for its leadership in precision ceramics in small sizes and thin cross sections. Long experience has helped produce miniature and sub-miniature ceramics to tolerances generally associated with fine metal work.

Uniformity of material and dimension is necessary to reach goals of micro-miniaturization.

AlSiMag ceramics are playing their part in increasing reliability of these components and in greatly reducing sizes of sub-miniature electronic components.

Even the close tolerances required in vacuum tube insulators and spacers are maintained in these AlSiMag microminiature ceramics without grinding. Tubes with walls as thin as .010" and flat shapes as thin as .005" are produced regularly.

These precision ceramics are widely used as electron tube components . . . supports, spacers, envelopes, windows . . .and as micromodule wafers, transistor bases, relay components, etc.

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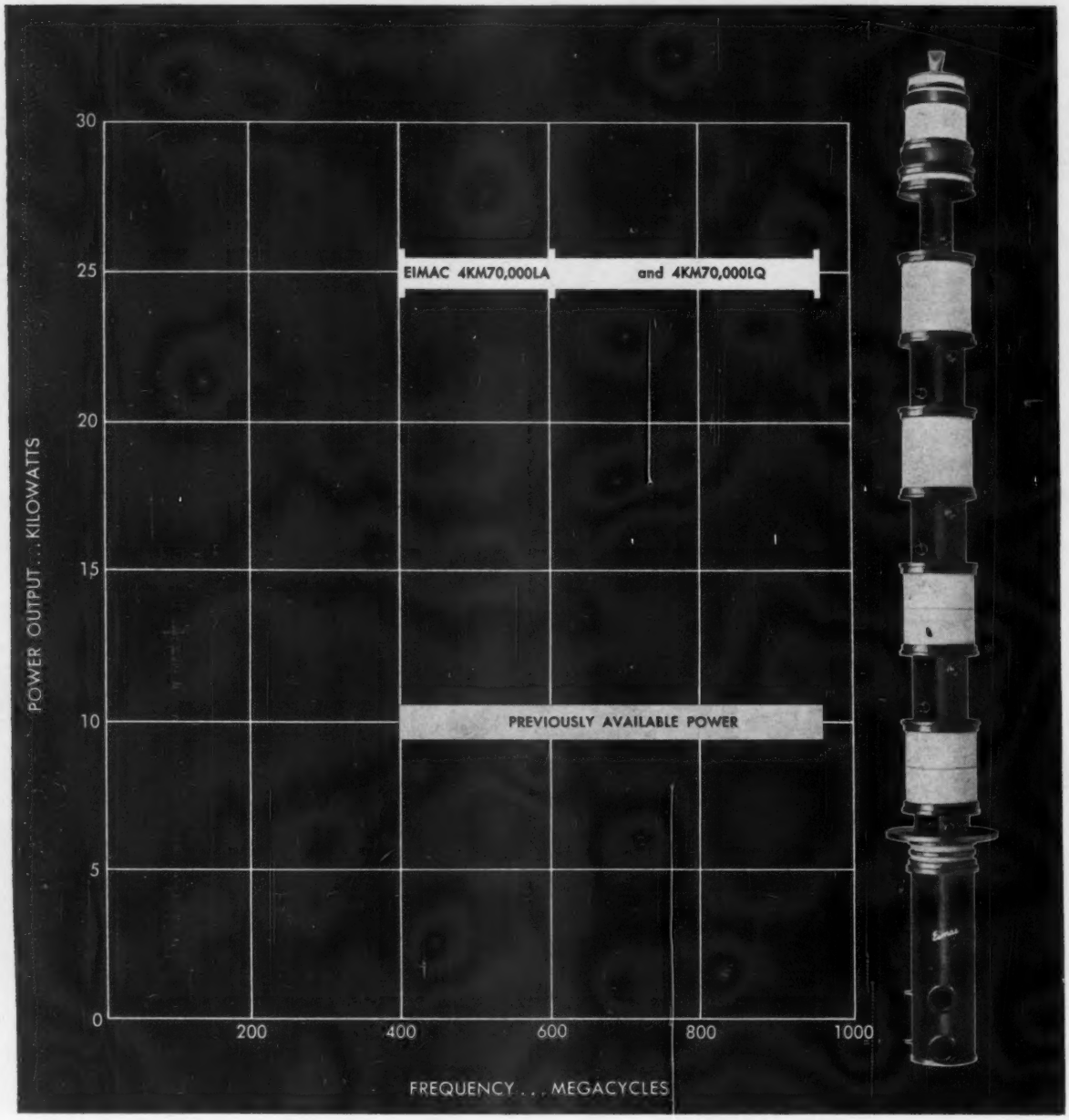


NOW...25KW AT 400-985 MEGACYCLES WITH EIMAC KLYSTRONS USING BeO RF WINDOWS

Eimac fills an important gap in the power vs. frequency chart with the introduction of the 4KM70,000LA and the 4KM70,000LQ. These new power-amplifier klystrons deliver minimum CW output of 25 kilowatts with a narrow band gain of 50db at frequencies from 400 to 985 megacycles. That's improved performance and higher power in this range than previously available.

The reason: these new ceramic and metal tubes are manufactured with windows of beryllium oxide—the amazing insulating material recently introduced by Eimac for vacuum tube use. It breaks through the problem of providing greater power-output capabilities in high power microwave tubes such as these by dissipating ever larger amounts of heat in dielectrics used as rf windows.

The 4KM70,000LA is designed for use at frequencies between 400 and 610 megacycles and the 4KM70,000LQ at frequencies between 610 and 985 megacycles. You'll find these tubes ideal for troposcatter communications and UHF television applications with an Eimac Klystron Amplifier Circuit Assembly to cover the specified frequency range. Eitel-McCullough, Inc., San Carlos, California.

HOW RCA DEVELOPS ELECTRON TUBES FOR INDUSTRY

"Right on target again!" said Hoyt Warren

"What's on target?" we asked, setting up our lights and camera.

"This entire run of RCA-5814-A industrial twin triodes checks out perfectly—right in the middle of the specified range values," said our Quality Control chief. "Hey! Have you got STAR in your photograph?"

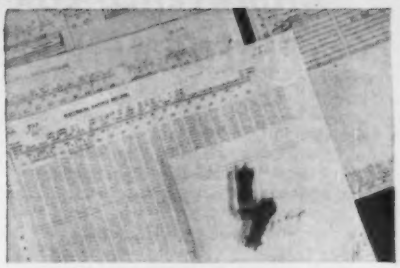
"STAR?" we asked as we focused on the 5814-A in his hand.

"This equipment here. It's the Special Tube Analyzing Recorder," said Hoyt. "It's the equipment Quality Control uses for automatic tube analysis."

"But *every single RCA tube* is factory-tested down in the plant," we protested, shifting lights for dramatic effect. "Do we have to test them again?"

"Absolutely," said Hoyt. "While the factory conducts initial tests, here, with our STAR equipment, we actually measure mu, rp, Po, Ib, gm and other characteristics at several points along the tube's performance curves. These tests are made on every run of tubes, and after various periods of life testing."

"Interesting," we said. "Now look serious and let's have that tube a little higher."



Sample pages of recorded test data provided by the Special Tube Analyzing equipment. Pre-programmed automatic tube analysis like this yields the large volume of data necessary for strict quality control and assures a degree of accuracy unattainable in tests subject to human error.

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RADIO CORPORATION OF AMERICA

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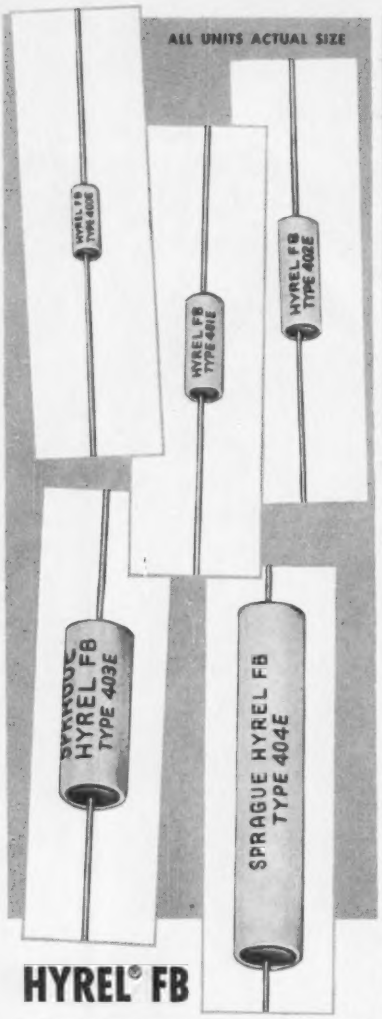

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WRITE FOR ENGINEERING BULLETIN 7010B

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THE MARK OF RELIABILITY

Litton Earnings Up 50 Percent

AFTER-TAX earnings of about $7,450,000, or a 50-percent increase over the comparable earnings of $4,954,031 from operations in the previous year, are announced in a preliminary report of **Litton Industries** 1960 fiscal year by C. B. Thornton, president and board chairman. The earnings reported are after provision for about $7,750,000 for federal and foreign taxes. Per-share earnings for the 4,158,602 shares of common stock oustanding came to about $1.75 for the year. Per-share earnings in the last fiscal year, adjusted for a two-for-one stock split in November 1959, were $1.33. Sales for the 1960 year were approximately $185 million, a gain of almost 50 percent over the preceding year.

Gertsch Products, Inc., Los Angeles manufacturer of precision electronic instruments, recorded a 20-percent profit drop on a 27-percent increase in sales for the fiscal year ended June 30. Sales came to $2,907,545 compared with $2,277,056 in fiscal 1959. However, net earnings were $160,710, equal to 5.5 percent after taxes or 50 cents per share on 318,783 outstanding shares. In 1959 earnings were $201,085 or 63 cents a share.

Telecomputing Corp., Los Angeles sales for the nine-month period ended July 31 this year increased to an all-time high of $38,219,830 as profits dipped 69 percent. Sales in the same period a year ago were $28,465,412. Funds spent on engineering and development amounted to $1,475,000 more than expended in the previous year. W. R. Whittaker, TC president says this accounts for the decline in earnings for the nine-month interval to $417,955, or 12 cents a share on 3,413,591 average common shares outstanding.

Figures reported in 1959 were $1,355,144, equal to 46 cents a share on 2,811,236 shares when a special federal tax credit of $246,000, or nine cents a share was available.

Siegler Corporation, Los Angeles, reports its most successful year in company history with earnings of $3,201,023, an increase of 45 percent over 1959. This was equal to $1.71 per share on the 1,871,595 common shares outstanding. In fiscal 1959, profits were $2,203,022, or $1.36 per share on 1,624,815 shares. The 15-percent rise in the number of outstanding shares is due to the issuance of 122,343 shares in merging **Magnetic Amplifiers, Inc.,** with Siegler, the declaration of a 4-percent stock dividend and the conversion of outstanding debentures. Sales for this fiscal year were $84,095,002, nine percent above last year.

Electronic Engineering Company of California, Santa Ana, reports consolidated sales of $1,665,000 for

25 MOST ACTIVE STOCKS

WEEK ENDING SEPTEMBER 23, 1960

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Gen Tel & Elec	1,495	28½	27¼	27½
Gen Dynamics	1,377	39⅜	33½	34⅛
Avco Corp	1,197	14¾	14	14¼
RCA	1,006	56	53¼	54
Univ Controls	991	18⅞	16¼	16¼
Ampex	919	28⅛	25½	25¾
Gen Electric	883	78	75	75½
Westinghouse	759	50⅝	48⅛	48⅝
Sperry Rand	739	21⅛	20⅛	20⅜
Litton Ind	652	75⅝	70⅝	71⅞
Int'l Tel & Tel	634	39	37	38⅜
Gen Inst	591	37¼	33½	34⅜
Texas Inst	534	187¼	177⅛	177¼
Varian Assoc	531	45¾	41⅛	43⅝
Elec & Mus Ind	484	7⅛	6⅜	6⅝
Standard Kollsman	462	22¾	21	21¼
Avnet Electronics	452	22⅛	18⅝	18⅝
Beckman Inst	433	92¼	85½	86½
Zenith	408	120¼	114¼	115⅛
Motorola	372	72¾	66¼	67½
Raytheon	349	36⅞	34½	34½
Victoreen Inst	348	15¼	13½	14
Philco Corp	345	22⅛	21¼	21¼
Loral Electronics	333	86⅝	78¼	79
Cenco	313	49½	45⅛	48¼

The above figures represent sales of electronics stocks on the New York and American Stock Exchanges. Listings are prepared exclusively for ELECTRONICS by Ira Haupt & Co., investment bankers.

NEW ISSUES PLANNED

	No. Shares	Price per Share
Ameco Electronic	100,000	$3.00
Dubrow Electronic	100,000	3.00
Electro-Science Invstrs.	772,000	*
Metcom Inc.	100,000	*
Pacific Electro Magnetics	60,000	5.00
Tech-Ohm Electronics	99,833	3.00

* to be announced

the 25-week period ended June 26 this year. Sales for the three-month period ended the same date were $1,020,000. Company president B. Dempster says, "Although the company earned a profit of $27,500 during the second quarter, this amount was not able to offset the loss sustained in the first quarter. For the six-month period from January to June, 1960 the firm showed a net loss of $43,000 as compared with a net income of $58,000 for the first six months of 1959.

Dorsett Electronics Labs., Norman, Okla., announces acquisition of two electronics companies: **Electronics Organ Arts Inc.**, Los Angeles, and **Electronics Inc.**, located near Denver, Colo. The two acquisitions involved a total of approximately 12,000 shares of previously authorized but unissued Dorsett common stock. About the same number of shares was involved for each of the newly acquired companies.

The Electronics, Inc., acquisition also calls for a nominal amount of cash.

American Electronics, Inc., Los Angeles, reports sales and earnings in the first half of 1960 as increased. For the period ended June 30, this year, net sales were $13,416,022 compared with $8,672,693 in the previous year. Net operating income at mid-year 1960 amounted to $264,991, or 30 cents a share on 877,708 shares.

A year ago, the figure was $226,406, which amounted to 26 cents per share on 873,572 common shares then outstanding.

United Industrial Corp., New York, reports distribution to stockholders of shares of its holdings in **Aircraft Armaments** and **U. S. Semiconductors.** Included in the distribution were about 53,000 shares of AA and approximately 106,000 shares of U. S. Semi-Conductor.

Distribution was made out of the parent company's ownership of 600,000 shares of Aircraft Armaments and one million shares of U. S. Semiconductor.

FLIGHT PROVEN
CH.12
DA-10 transistorized
DA-11 DC amplifiers
The DA-10 and DA-11 transistorized low level DC amplifiers are two-year veterans of the nation's missile and space programs, having been flown in Discoverer, Atlas, Titan, Thor, Tiros, Hound Dog, SD-4 and SD-5 Surveillance Drones. Applications include strain gage, thermocouple and other low level amplification. Gain control adjustment provides wide flexibility in input signals. The DA-10 and DA-11 have a broad frequency response which makes them suitable for amplifying commutated signals. Characteristics of the DA-10 and DA-11 include:
• DC to 2500 Cycle Response
• Isolated Transformer Input
• Carrier Rejection 40 db minimum at the output
• Continuous Gain Adjustment from 20 to 600
• Input Signal 0 to ±5 mv adjustable to 0 ±125 mv
0 to +10 mv adjustable to 0 +250 mv
0 to −10 mv adjustable to 0 −250 mv
• Input Impedance: 10,000 ohms
• Output: 0-5 vdc at 12,000 ohm source impedance
• Linearity: ±1% max. best straight line
• Stability: ±2% max. total gain and zero drift
• Vibration: 20 g's peak from 15 to 2000 cps
The DA-10 operates from +24 vdc to +30 vdc at 5°F to 212°F.
The DA-11 operates from 20 vdc ±0.05% regulated at 32°F to 150°F.
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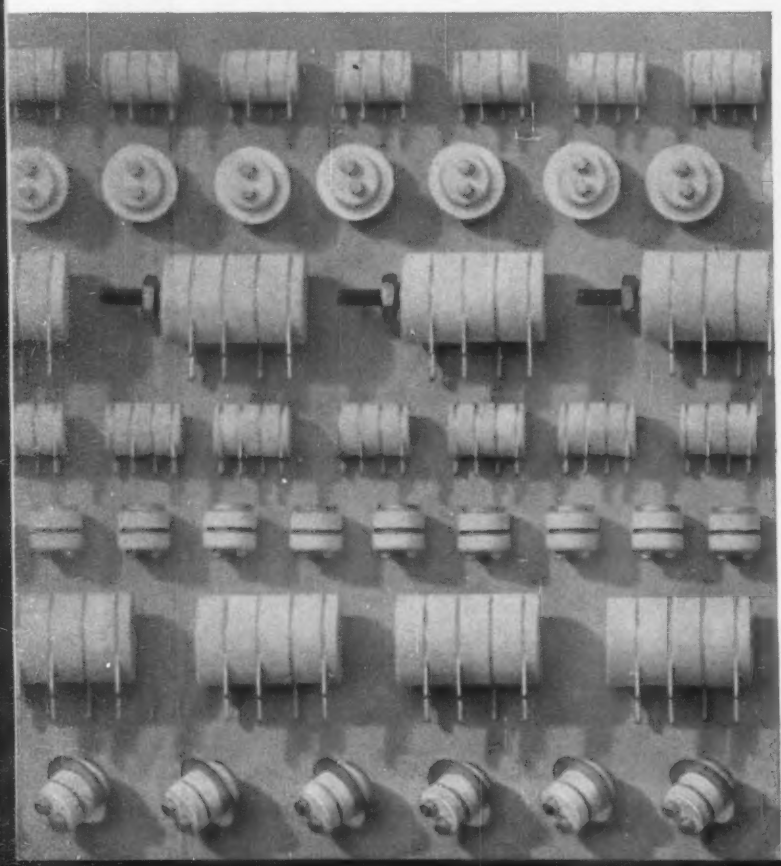


(ACTUAL SIZE)

7462
RF-amplifier triode

7486
RF oscillator-mixer triode

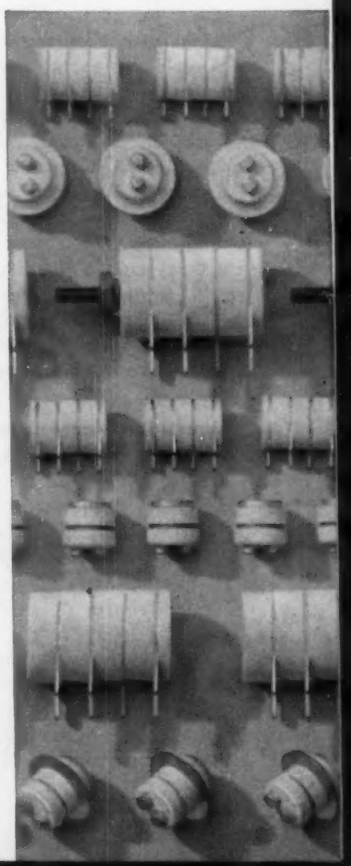
7296
VHF-UHF low-power triode, shown with mounting bolt

7625
High voltage-gain triode

7266
VHF-UHF detector diode

Developmental, broadband, 40,000-G_m triode

7077
RF-amplifier triode



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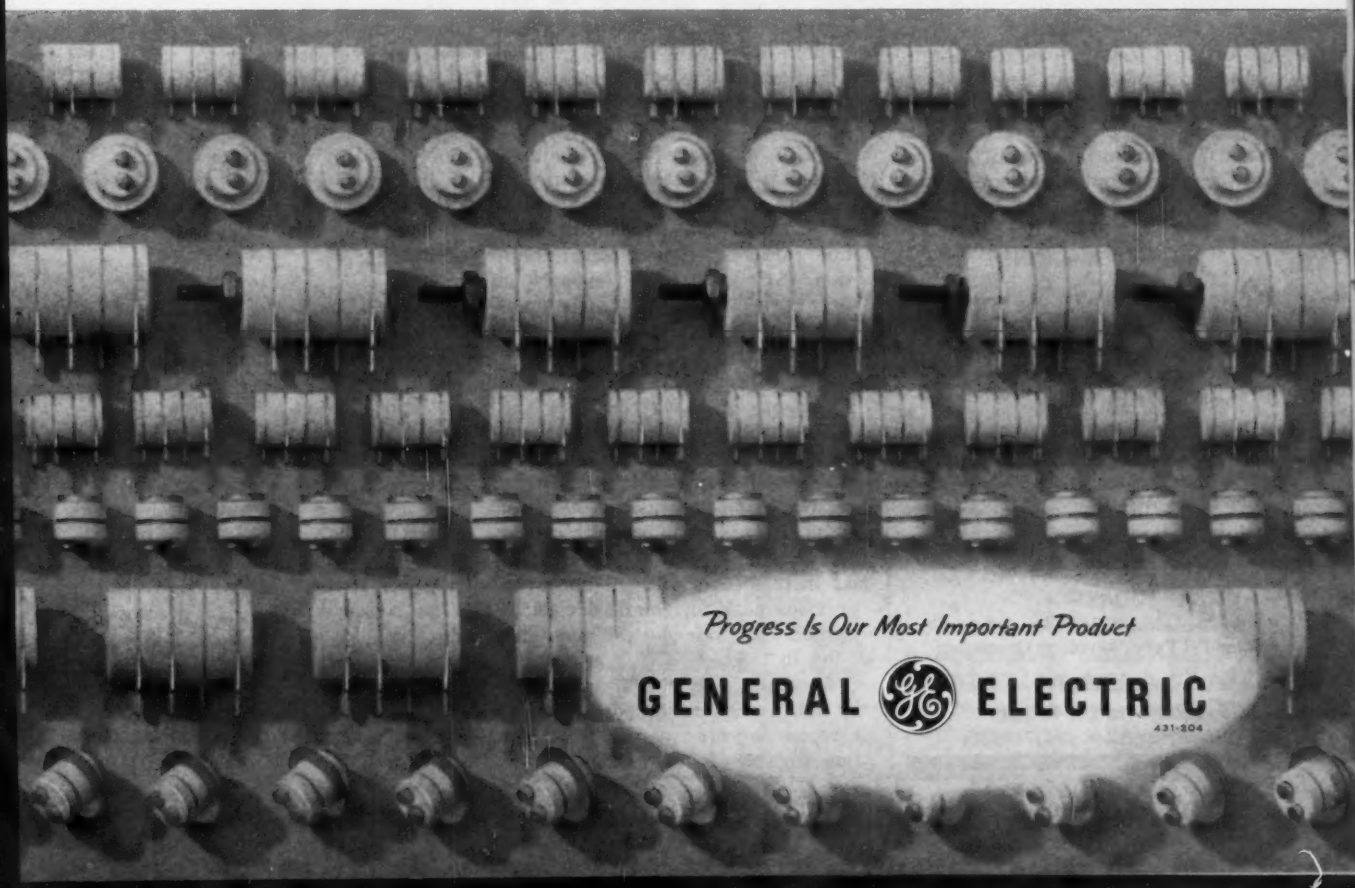

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50μ sec. to 90 sec.
WAVEFORM
Square, Triangular, Sine
0.01 cps to 2000 cps
GENERATOR

Through unique design, the Parabam Model P-1 Pulse-Waveform Generator provides virtually transient free square, triangular and sine waves plus variable length pulses. Has sufficient output to drive power transistors and relays, electrohydraulic valves and other units directly from the output terminals. *Applications*..., test and development of servomechanisms, computers, input-output devices and geophysical equipment.

MODEL P-1 SPECIFICATIONS

- Waveforms: Sinusoidal, square and triangular.
- Frequency: continuously variable in 10 ranges ... 0.01 cps to 2000 cps.
- Frequency stable within 1%.
- Pulse length continuously variable from 50μ sec to 90 seconds.
- Pulse amplitude ... 0 to 60 volts, 200 milliamps max. current.
- Rise/Fall time approx. 2μ sec.
- Cabinet or rack mounted.

WRITE TODAY —
for Technical Bulletin No. 660-6 on the P-1 Pulse-Waveform Generator.

PARABAM, INC.
13000 YUKON AVENUE
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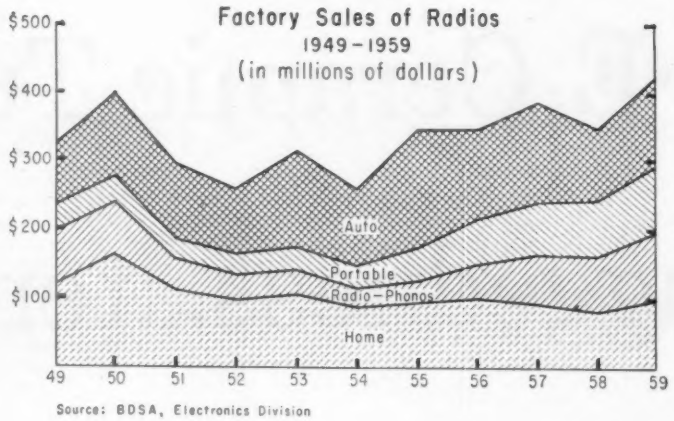
1959 RADIO SALES HIGHEST



AN EIGHT PERCENT dollar increase in factory sales of radios and radio-phonographs can be expected this year, according to Business and Defense Services Administration, Electronics Division. Demand for new types of equipment—f-m radios, transistorized table models and the newly introduced f-m auto radio—should push sales to 17 million units valued at $460 million.

Information comes from a new BDSA report "Radios: U. S. Production and Foreign Trade, 1949-1959". An exceptionally complete report, it provides five and ten-year records of both dollar and unit radio sales broken down into factory sales, U. S. apparent consumption, U. S. imports and exports by four major radio types. It is available for a nickel from U. S. Government Printing Office.

The report shows that factory shipments of radio receivers and radio-phonographs reached a new record high for the decade last year, despite increased foreign competition and shrinking exports. Sales totaled 16 million units valued at $423.8 million, a 23-percent dollar increase over 1958, topping the previous peak for the decade—15.8 million units valued at $398 million —set in 1950.

Biggest stride in 1959 was made by auto radios, up 30 percent from a recession-year low of $101.8 million in 1958 to $132.6 million in 1959, and nearly one and a half times the value sold in 1949.

At present, competition from imports is negligible, since foreign makers are unable to design fast enough to meet annual restyling in U. S. automobiles, BDSA reports. But the new f-m auto radio is designed for mounting below the instrument panel, and imports of this type may increase.

Sales of home radios (including radio receiver chassis), which sagged with the advent of television, have revived in recent years. In 1959 home radio sales reached their highest point in three years —5.6 million units valued at $98.3 million.

Radio-phono sales last year totaled $99.2 million—highest value of the decade. Sales have been rising at an average annual rate of 33 percent since 1954.

Portable radios also hit the high point of the decade in 1959, despite competition from imported transistor radios. They totaled slightly more than 4 million units valued at $93.7 million, or nearly three times the 1949 value. Unit sales have been rising steadily since 1951 at an average rate of 11 percent annually.

Import growth in the last six years has been dramatic. Report shows that the total number of radios imported in 1959 was 233 times the 1953 figure. The 1959 im-

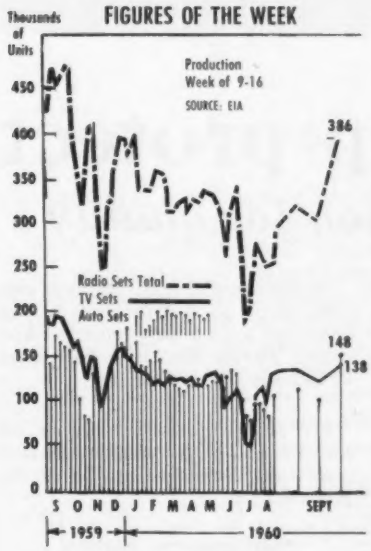
IN DECADE

ports totaled 5.8 million units valued at $69.7 million, or about 14 percent of U. S. consumption. About 94 percent of imported radios, or 5.5 million units valued at $55 million, were Japanese transistor radios.

Radio-phono imports have also increased sharply, from 2,000 in 1953 to 110,000 in 1959. Radio-phonographs accounted for about two-thirds of the value of West German imports, estimated at about 265,000 units worth $13.5 million.

Radio exports, however, have declined steadily since 1949, when 464,000 units valued at $13.6 million were shipped overseas. In 1959 only 289,000 units valued at $7.7 million were exported. Only radio group to show an increase in 1959 was auto radios, up 20 percent from 53,414 units in 1958 to 64,057 units in 1959. But value was down 6 percent from $1.9 million in 1958 to $1.8 million in 1959.

FIGURES OF THE WEEK



LATEST MONTHLY SALES TOTALS

(Source: EIA)
(Add 000)

	July 1960	June 1960	Change From One Year Ago
Rec. Tubes, Value	$28,810	$29,065	— 3.3%
Rec. Tubes, Units	34,883	33,916	— 4.2%
Pic. Tubes, Value	$13,898	$15,505	— 5.1%
Pic. Tubes, Units	682	757	— 9.1%
Transistors, Value	$18,084	$27,342	+15.8%
Transistors, Units	7,071	10,392	+17.3%

Engineering notes from the **SM/I REPORTER**

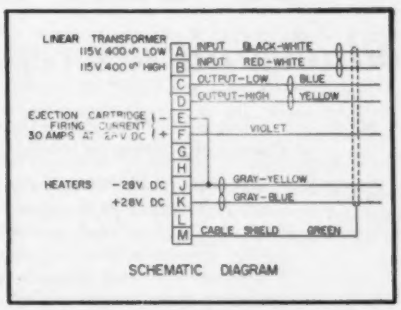
BY STANLEY M. INGERSOLL, *Capabilities Engineer*

Report No. 12
TV 2020 Ejectable Vane Angle of Attack Transducer

Precision built for stringent missile applications, the self-powered TV 2020 provides an AC output proportional to the direction of air flow surrounding a vehicle. The ejectable vane, an optional feature, is affixed to the shaft by calibrated shear pins. It may be ejected by a minimal explosive charge contained within the vane and initiated by an electrical impulse. A heater within the metal of the vane itself makes it invulnerable to icing. The vane arm, shaft and counterweight structure of the TV 2020 are stainless steel and its stable case and structure are cast aluminum. Silicone oil of relatively low viscosity is used as the damping medium. The vane arm is interchangeable and will work with any transducer of the TV 2020 type.

Typical Performance Specifications

Angular Range	±15°
Electrical Input	115 volts at 400 cps
Electrical Output	0.3 volts rms 400 cps per degree
Total static error (max.)	Between +7.5° and −7.5° ±0.15°
	between +7.5° and +15° ±0.45°
	between −7.5° and −15° ±0.45°
Operating Mach Number Range	0.2 to 7.0
Operating Temperature Range	−54° to +125°C.
Heater:	
Power Requirements	250 watts
Operating Voltage	28 volts DC
Size:	
	4¾" diameter of mounting flange 4" deep
Total Weight	3 lbs., 5 oz.



SCHEMATIC DIAGRAM

TV 2020
ANGLE OF ATTACK
TRANSDUCER

For more information and complete operating specifications, write or wire SM/I today. Address your inquiry to Stanley M. Ingersoll, Capabilities Engineer.

SM/I

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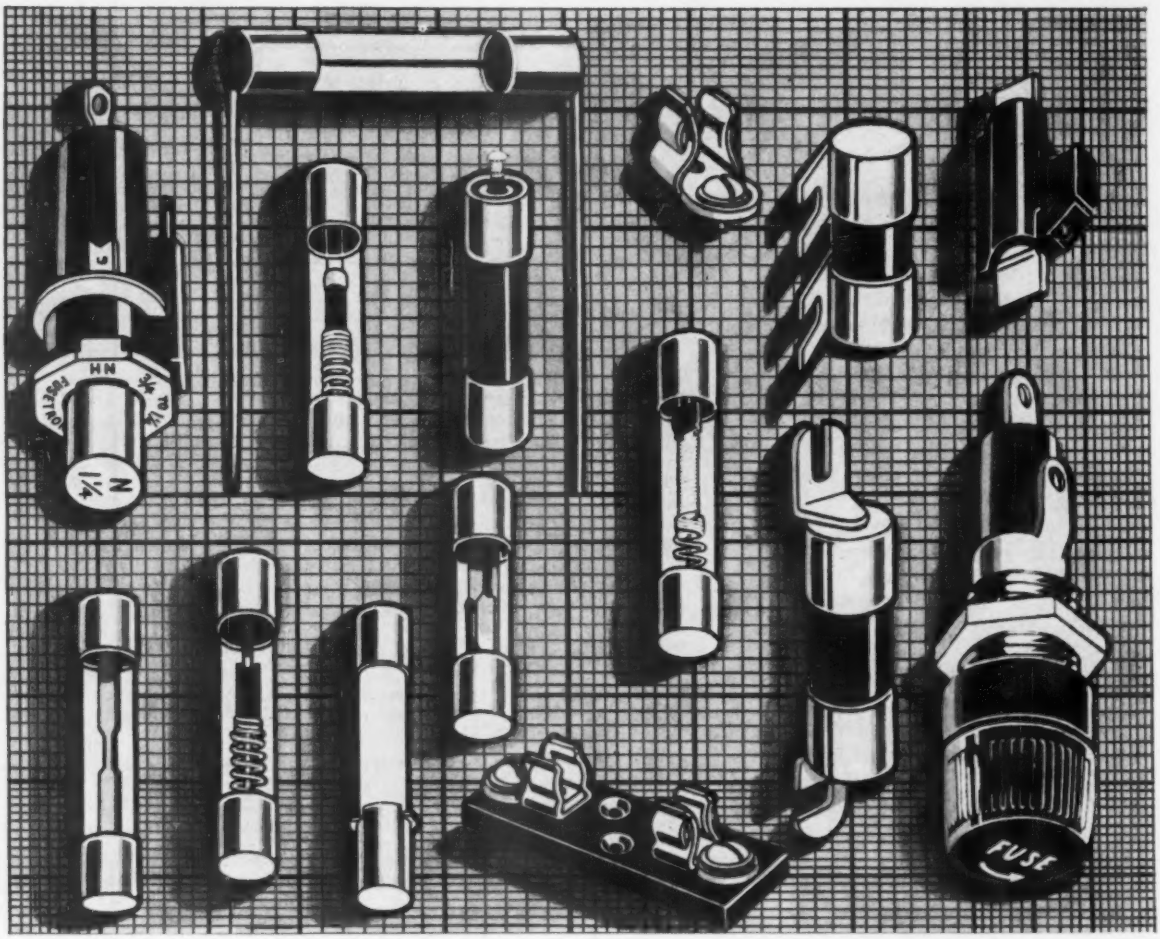
Los Angeles Division
12500 Aviation Boulevard
Hawthorne, California

CIRCLE 25 ON READER SERVICE CARD



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You get double protection when you specify BUSS fuses.

First, BUSS fuses are designed and manufactured to give maximum electrical protection.

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Every BUSS fuse is carefully tested in a sensitive electronic device that automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

This is your assurance that BUSS fuses will operate as intended.

Second, BUSS fuses help protect your reputation as a quality manufacturer. A fuse that opens prematurely causes a needless shutdown. Likewise, one that doesn't function properly may cause other components to burn out or be damaged. In either case, it's an annoying headache for the customer who buys your equipment. More often than not, he will blame your product for his trouble.

With dependable BUSS fuses, you need have no worries that faulty fuses will give your product a bad name. That's why it makes good sense to specify BUSS fuses.

For more information on BUSS and FUSETRON small dimension fuses and fuseholders . . . Write for bulletin SFB.

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McGraw-Edison Co.
University at Jefferson, St. Louis 7, Mo.

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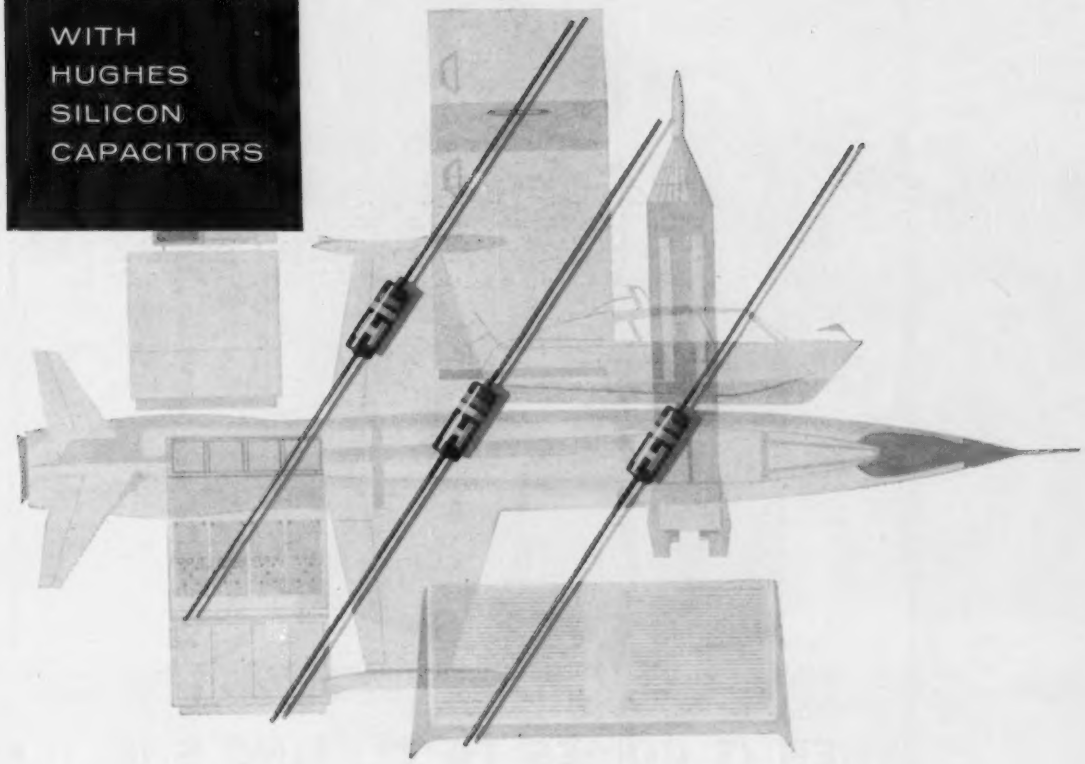
CAPACITORS



new ways to design new things

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TYPE	CAPACITY ±20% (@ −4VDC)	MAXIMUM VOLTAGE	TYPICAL CAPACITY RANGE (0.1V TO MAXIMUM VOLTAGE)	TYPICAL Q (@ 5Mc AND MAXIMUM VOLTAGE)	TYPICAL Q (@ 50 Mc AND MAXIMUM VOLTAGE)
1N950	35 pf	130 VDC	6 to 88 pf	360	39
1N951	50 pf	80 VDC	12 to 120 pf	330	36
1N952	70 pf	60 VDC	20 to 170 pf	270	30
1N953	100 pf	25 VDC	46 to 240 pf	200	23
1N954	35 pf	25 VDC	14 to 88 pf	175	20
1N955	50 pf	25 VDC	22 to 120 pf	175	20
1N956	70 pf	25 VDC	32 to 170 pf	175	20

Operating temperature range: −65°C to +150°C.

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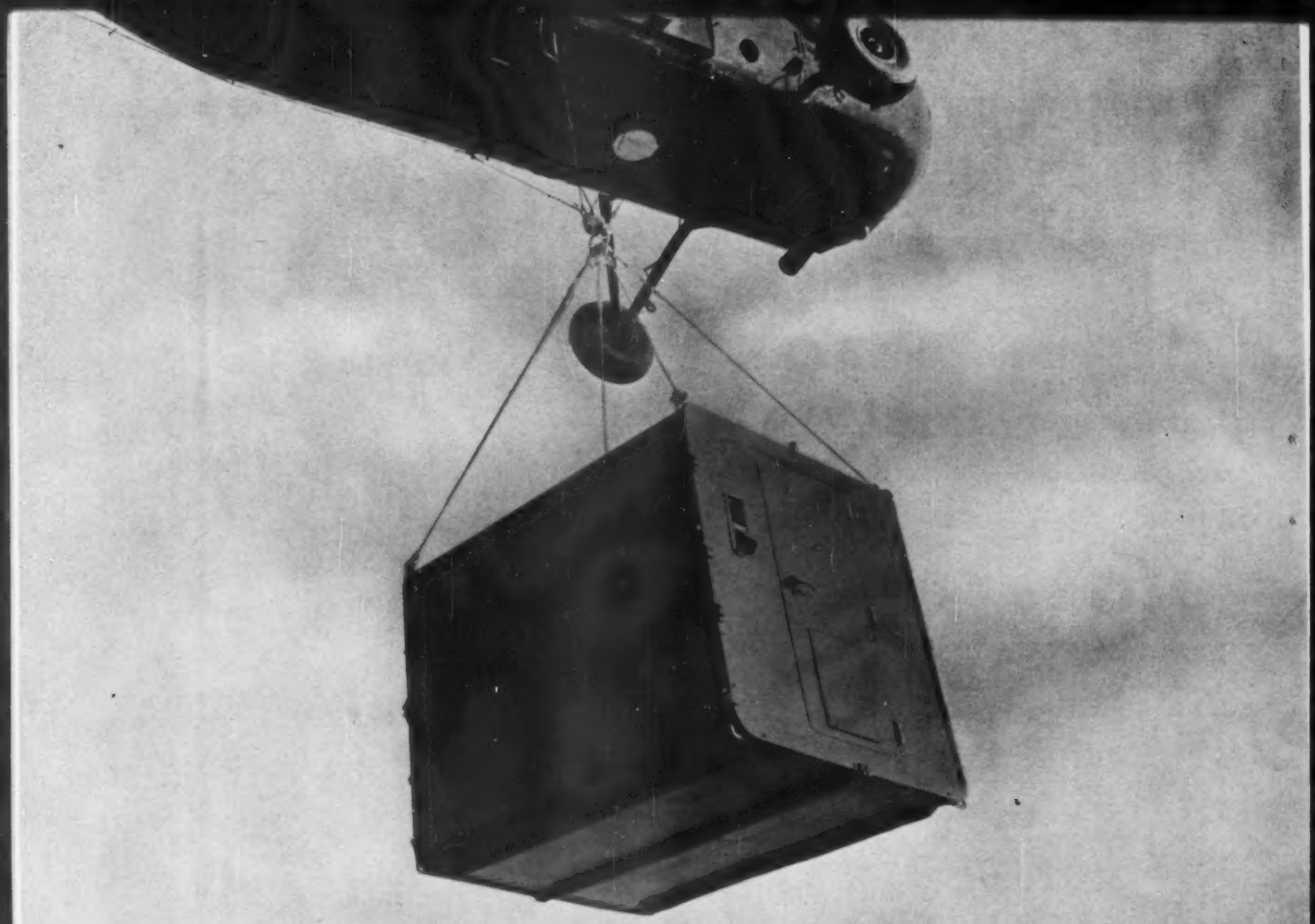
CIRCLE 27 ON READER SERVICE CARD

CIRCLE 28 ON READER SERVICE CARD →



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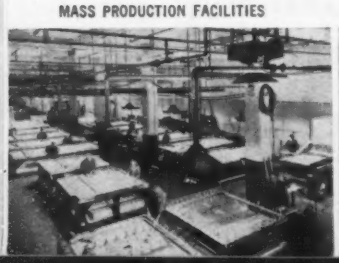

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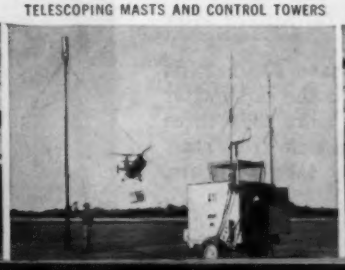


HELICOP-HUTS AWAITING DELIVERY

Mercury Ground Network:

The first man-in-orbit system, like the Wright brothers' airplane, will be followed by more ambitious programs. Here's how the Mercury tracking and ground instrumentation system works and what will be needed for later projects

By JOHN F. MASON, Associate Editor

CAPE CANAVERAL, FLA.—Speculation is high that the Soviets will have a man in orbit long before we do. The Russians recognized the propaganda value of such an accomplishment some years ago and were well along in their efforts before we ever began.

But regardless of what the Russians accomplish, the National Aeronautics and Space Administration's Project Mercury will proceed to completion.

The ground system will be completed by Jan. 25, 1961. Four or five astronauts will be fired into ballistic trajectories 125 miles high and 200 miles down range. And late in 1961, the first astronaut is scheduled to be put into orbit by an Atlas missile.

Whether Mercury comes in first or second, the engineering that went into the project is a major achievement. Later programs with more ambitious missions will require more sophisticated systems.

Mercury will provide a basis for new designs to strengthen these later systems and expand their capabilities.

The Mercury tracking and ground communications system is a first in our space effort because it must fulfill the new and extra requirements placed on it by the satellite's human payload and by the short time the mission will take.

Unmanned satellites don't demand the constant attention that manned satellites will. It is enough to spot check the initial peregrinations of a payload of instruments as it crosses minitrack fences and determine its orbital pattern after three or four orbits.

Mercury will have finished its job and be back on the earth after it makes a little more than three trips around. The time from start to finish will only take 4½ hours.

The Mercury vehicle must be tracked from the moment it leaves the launch pad in Cape Canaveral, Fla., almost continuously along its route, until the capsule lands in the Atlantic ocean near Florida.

Prime contractor for the tracking and ground instrumentation system is Western Electric, also responsible for project management, overall logistics, ground communications, and training of government-furnished operating personnel.

The system is being built in record time. When the job is completed it will have taken just 18 months. Because of this tight schedule, and for economy, almost all equipment used is off the shelf. Project Manager R. M. Goetchius told ELECTRONICS the major problems in the job have been "time, geography and welding a team together to do the job." He accomplished the latter by holding biweekly group meetings with project managers from major contractors

Ground communications use landlines, submarine cables and h-f radio

One of these seven astronauts (standing) will be the first American to orbit the earth. His flight will be monitored and to some extent controlled from NASA's control room, here, in Cape Canaveral, Fla.

Roadmap for Future Space Systems

and a representative from NASA. Every aspect of the job was analyzed at these meetings.

Bell Telephone Laboratories is responsible for systems engineering, engineering consultation and the command and control displays.

IBM will perform the computer programming and will install and maintain the new computers. Bendix is providing radar and associated digital data processing equipment, ground-to-air communications, telemetry and site display equipment. Burns & Roe conducted the site surveys and is designing and constructing buildings and antennas and providing power. More than 630 first tier subcontractors have contributed to the work.

Western Electric's contract for the ground system is about $35 million to date. Another $5 million for ground equipment was government furnished.

The ground network consists of 18 sites (see map) including a control center at Cape Canaveral, Fla. The computing and communications center is at the Goddard Space Flight Center, Beltsville, Md.

Five of the sites, as well as the control center at Canaveral, are on missile ranges where radar and other facilities already existed. Two stations are on ships.

Site equipment consists of radars for tracking, telemetry and vehicle communication facilities, and a ground communications and data transmission system.

All stations will be linked with the computing and control centers by a communications network. Sixteen of the stations will be equipped with telemetry receivers and will have facilities for voice communications. Six stations will have command control systems. Computers will be used at Goddard, Bermuda and Canaveral. Eleven states will have radar. Three of these will have a C band radar, RCA's AN/FPS-16; four will have an S band, Reeves Instrument's Verlort; and three sites will be equipped with both C and S band systems. The AN/FPS-16 has a tracking range of 500 n. mi. The Verlort will be used to track up to 700 n. mi.

The sites using radar will be equipped with: digital data conversion and processing equipment to prepare six-second data messages for transmission to the computing center; a boresight tower and calibration facility; equipment to record radar data locally—one sample every six seconds on punched paper; an active acquisition aid that uses direction finding techniques and operates on either of the two continuous telemetry signals from both capsule transmitters to provide angle data for radar acquisition; and an acquisition data control system to provide pointing data to all steerable antennas.

The active acquisition aid is an automatic tracking unit with a beamwidth of 20 degrees. It uses two interferometer antenna pairs, continuously positioned to null by use of phase comparison receivers controlling a servo system.

Voice communications are provided from each station using uhf and to a lesser degree, h-f. One-way emergency voice uses uhf.

The telemetry receiving system consists of an r-f section, a demodulation and separation section, a recorder section, a monitor and test section and data display equipment. Both high-power and low-power telemetry are also in the uhf range. A teletypewriter message summarizing the data received during each passage will be transmitted to the control center.

The receiving antenna systems consist of two quad-helix steerable arrays. Future systems may include parametric preamplifiers instead of the present preamplifiers to provide a 2 to 3 db improvement in system noise figure over the present 4 db figure.

Master and standby h-f and uhf transmitters especially modified for frequency stability and interference requirements are also provided. For additional backup, voice modulators have been added to the command control transmitters to provide the astronaut with emergency voice reception on the capsule command receiver.

Some sites have a 10Kw power amplifier for improving the received signal level. Reading and storage requirements of certain digital timing functions to be transmitted necessitated the design of coder controller systems capable of supplying coding input information simultaneously to both master and standby transmitting systems.

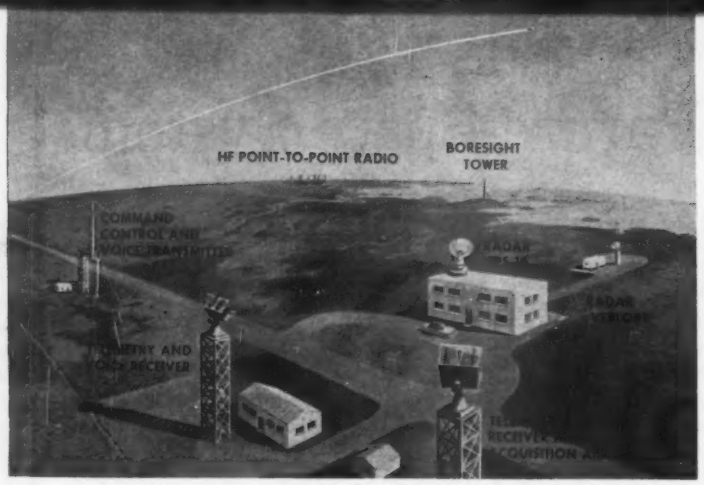
The antenna terminals are fed to high Q r-f multiplexers, which separate the two telemetry signals and the uhf air-ground voice communications frequency. The multiplexers feed individual vacuum-tube preamplifiers, narrow-banded to achieve noise figures of 3.5 db. Receiver outputs on each of the two telemetry frequencies are combined.

The telemetered quantities selected for real-time display are presented at a three-position console located in the operations area at each site except Bermuda and Canaveral.

Bendix also supplies a site data console simulator for training; acquisition data consoles; communication technicians' consoles; and radar data conversion equipment.

Heart of the network are two IBM 7090 computers at Goddard, a 709 in Bermuda and a 709 and a GE-Burroughs computer at Canaveral. The radar and telemetry sites feed data and other messages to Goddard. Here radar data and launch phase telemetry data automatically enter the computer memories. After processing, Goddard transmits display data to Canaveral and acquisition data and other messages to the sites.

Bermuda with its two radars and a computer, is a self-contained complex. If Cape Canaveral loses contact with the capsule, Bermuda will decide the first "moment of truth" for the astronaut. Minutes after launch, as the astronaut, already in orbit, gets halfway from Canaveral to Bermuda, it must be decided whether to let him continue the mission or bring him down. Data from the Bermuda radar is fed into the local computer which assesses the attained orbit and gives the Bermuda flight dynamics officer a go/no-go recommendation. His decision must be made in less than 30 seconds if the



Composite site conception shows equipment used in the ground system

. . . Future Space Systems

capsule is to be brought down before it reaches Africa.

Mercury is a real-time system. IBM has designed and made a special data communications channel for installation on the Bermuda and Goddard computers. These channels, consisting of high-speed and low-speed input and output subchannels, will accept data directly from communication lines through terminal equipment. This eliminates any intermediate data processing tools such as punched cards or tape.

All during the orbital phase, display messages consisting of orbital elements, positional data, and firing times for retrorockets for certain eventualities and recovery areas are being furnished to the control center two times a second. Acquisition messages are continuously being refined and sent to the sites from the computer.

The computer is completely automatic. IBM devised a computer program called the program monitor. Its purpose is to make those decisions that a human operator would make if he were part of the system. The monitor will constantly be asking yes or no questions of the computer as to the progress of the mission, the availability of data, or the status of the computer programs. It will proceed on its course of action or adopt a new course depending on whether it receives a yes or no answer.

The communications system, built by Western Electric, is actually a vast data handling system. It provides the following transmission functions: teletypewriter messages between the stations and Goddard and Canaveral; acquisition information from Goddard to tracking and telemetry stations; commands and instructions from Canaveral to the stations; digital tracking data from the tracking stations to Goddard; telemetry summary messages between stations and Canaveral; high-speed data transmission between Goddard and Canaveral for computation and display; and voice communications between some stations and Goddard and Canaveral.

The system involves 58,000 route miles of communications facilities. The entire system comprises 125,000 circuit miles—about 88,000 miles of teletypewriter circuits, 32,000 miles of telephone circuits and 5,000 miles of high-speed data circuits.

Teletypewriter information into and out of Goddard will be handled by an automatic switching system. A significant portion of the traffic will be information generated automatically by the radars or computers and transmitted at teletypewriter speeds. High-speed data circuits (1,000 bits per second) between the computers at Goddard and Canaveral will be provided to handle the large volume of data flowing between these two points.

Later manned spacecraft will operate at greater distances from the earth and for longer mission periods.

Project Apollo, the 3-men-in-space vehicle, will orbit more than 3½ times and at altitudes higher than Mercury's 120 miles. Vehicles taking different itineraries—for example a polar orbit—will require new, individual tracking chains. Later systems will orbit the earth and moon.

NASA is asking industry to determine what equipment is needed for such flights. Though the funds NASA has been given for this purpose amount to only $1 million at present for Apollo, more money will be forthcoming.

Some of the requirements for future systems were described recently in Washington by William E. Ward, Ground Radar Systems, Lincoln Laboratory, MIT, at the National Symposium on Space Electronics and Telemetry.

Here are some of the points Ward feels should be looked at:

The consideration of two-way communication links and a beacon-tracking radar to form a unified instrumentation system is already in widespread use. The capabilities of such systems should be rounded out by the addition of a compatible arrangement for radar skin tracking.

The field of optimum signal and waveform design continues to offer a broad field for fruitful development leading to the "best" parameter estimation under the constraints of the mission, the schedule and the budget.

There will always be an insatiable demand by the customer for more tracking and communication capability, with corresponding pressures for greater transmitted power, larger antenna apertures and more sensitive receivers.

In the field of precise-tracking instrumentation systems, there is a general retreat from attempts to make increasingly precise angle and angle-rate measurements from a single site. There is a growing emphasis on range- and range-rate-only tracking systems such as GE's Mistram (ELECTRONICS, p 38, July 29).

Very accurate antenna mounts for larger and larger ground antennas promise to be enormously difficult and expensive to build. The angle precisions that are required for some purposes exceed those of the most precise present-day radars

(such as the AN/FPS-16) and approach those of astronomy. The corrections for pointing errors due to systematic and fluctuating atmospheric perturbation become more important as the precision of angle measurement is increased. These propagation effects can perhaps be compensated for more easily in the overall system by making range (and range-rate) corrections.

No development of large, superprecise antenna mounts is foreseen. There will continue to be some requirements for larger mounts having precisions of the class of the best present mounts. Antenna will continue to get bigger and demands will be made for more and more accurate radiating and reflecting surfaces on these antennas.

The development and application of low-noise receivers will surely continue. More efficient coding and decoding means for the transmission and reception of signals will be developed and found useful.

The integration of the radar components and the computer components will become tighter, to the point that the subsystems cannot be distinguished.

Some observers feel that an outstanding deficency in the ground instrumentation for the radar tracking of space vehicles lies in the department of skin tracking. If the beacon-tracking transponder does not work during the launch phase, the mission must probably be abandoned. It will be essential to have a backup skin-tracking radar capability during launch so that the mission can be terminated if the beacon-tracking system fails.

These considerations hold true even more strongly upon the return of a manned spacecraft from some distant mission since it is not likely that all the vehicle electronics will be working. It will be essential to track and to do one's best to communicate with the vehicle so that it can make an effective reentry.

The means for achieving satisfactory skin tracking of manned spacecraft of practical size at ranges of thousands of miles are available. All that is required is money.

Computers for future systems will probably require increased memory size and a reduction in cycle time.

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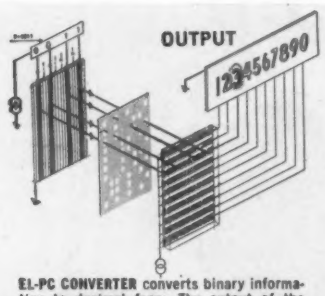
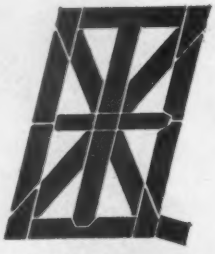
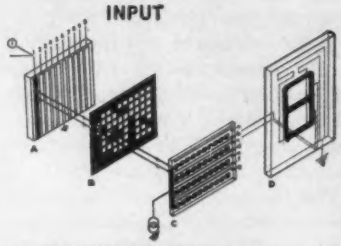


EL-PC CONVERTER converts binary information to decimal form. The output of the CONVERTER can be used as the input to the TRANSLATOR shown below. EL-PC matrices for decimal-to-binary conversion are also available from Sylvania.



EL "READOUT" DEVICE is composed of strips of electroluminescent lamps, insulated from each other and separately terminated. By selective excitation of the "strips," alpha-numeric symbols are produced for readout purposes.



EL-PC "TRANSLATOR" makes practicable use of the luminous properties of EL phosphors on panel "A" and of photoconductive elements on panel "C." Mask "B" enables selective excitation of the electroluminescent phosphors on readout panel "D."

Physical dimensions of EL-PC panels are shown here in exaggerated scale for purposes of clarity.

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For example, new "crossed-grid" panels have been developed that utilize conductive strips placed at right angles to each other on opposite sides of an electroluminescent phosphor layer. These "strips" when separately excited glow at the points of intersection. This provides a point of light that can be moved in X-Y directions to create a display that is exceptionally small in front-to-back dimensions and is highly useful in position-plotting applications.

Sylvania Sales Engineers can give you details on specific EL-PC devices. Too, write for ten-page brochure, "Sylvania Electroluminescent-Photoconductive Devices," to Electronic Tubes Division, Sylvania Electric Products Inc., Dept. EL, 1100 Main Street, Buffalo, N.Y.

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Burroughs account and amount imprinter (left) places magnetic ink characters on uncoded checks as first step in automatic processing. Sorter-reader (right) developed jointly by Pitney-Bowes and National Cash Register separates checks according to banks originating them by reading MICR code

BANKS WANT CHECK HANDLING EQUIPMENT

Federal Reserve to Test Five Systems

By THOMAS EMMA, Associate Editor

FIVE-WAY EVALUATION of electronic check handling equipment is nearing countdown this week as five system proponents ready gear for delivery to Federal Reserve Banks by January.

Faced with the prospect of having to handle upwards of 20 billion checks a year by 1970, Federal Reserve officials have called on five electronics teams to come up with equipment to handle the problem.

According to Fed spokesmen, five cities will be involved, with each installation to be made by a different manufacturer. The Federal Reserve in Boston will test an installation by National Cash Register. In Chicago, a Burroughs system will be evaluated, and in New York, Ferranti-Packard and Pitney Bowes are joining forces.

The Philadelphia Federal Reserve will evaluate an IBM system, while San Francisco will use equipment by National Data Processing Corp.

The basic job of all systems will be the same. Incoming checks from all over the country will go to Federal Reserve banks to be cleared, processed and returned to the originating banks as usual. The electronic equipment will be used to encode the amount and the identifying bank number on each check in magnetic ink; to sort the checks, once encoded, and to strike totals for each bundle of checks for use by the bank they will be sent to. Print-out facilities will be provided to prepare transit documents and make permanent records of checks processed.

In general, processing will follow this order: a bundle of checks will be received at the Federal Bank from corresponding banks; they will be manually processed by a clerical worker who will imprint amount and, if needed, bank transit identification on each check with a device resembling an adding machine. The imprint will be in magnetic-ink characters. The imprint encoder device will also total the amount of each bundle for comparison with the amount indicated by the correspondent bank.

From this point on, no further manual processing will be needed. The bundles of checks are fed into a sorter which will automatically separate them and deposit them in bins according to the bank from which they originated. The checks, along with total amount of the bundle will then be removed from the bin and mailed to their designation.

Federal Reserve planners say the forthcoming tests will be meaningful only if other banks along the way step up their activities as far as MICR (Magnetic Ink Character Recognition) is concerned. As more and more banks begin marking check amount and identification numbers in magnetic ink, less preliminary processing will be needed.

Progress along these lines is encouraging, according to recent Fed survey. Since spring of this year, the Fed has been supplying preprinted check forms to member and nonmember banks for drawing on their Fed accounts. It has also been preprinting its own checks.

A survey taken in June by the Federal Reserve bank of New York showed that 125 of the approximately 1,000 banking offices to which it sends checks were using magnetic ink. This is a threefold increase over the number using MICR at the beginning of 1960.

By June of this year, nearly all New York clearing houses had begun to provide their customers with magnetically encoded checks. Some indication of the rate of MICR usage may be had from the fact that by mid-year, 82 checks out of every thousand carried magnetic routing information. This compared with a figure of 16 per thousand six months earlier for the New York area. Outside of New York City, 58 out of each thousand checks drawn on the New York Fed carried MICR routing, as compared with only 22 per thousand in January.

NEC Expects Full House Next Week

Microelectronics, digital data transmission get multiple sessions. Research tours among new features

Wives are encouraged to share tours, social program planned just for them

Limited booth space accommodates 300 exhibitors. Another 150 couldn't be fitted in this year

CHICAGO—HUSKY EXPANSION of electronics, especially in the Midwest, will stretch seams of the Sherman Hotel to capacity next week with at least 11,000 visitors expected to attend the 16th annual National Electronics Conference here Oct. 10-12.

Nippon Electric is bringing its diodes and other solid state devices from halfway around the world to exhibit along with nearly 300 companies showing their newest products of electronic research and development in 275 booths, maximum number the hotel can accommodate.

"All booths were gone within weeks after we started allocating space early in April," said Rudolph Napolitan, general manager of the show. "We're holding requests for 150 more booths than we can accommodate this year, and we're already planning our move to the International Ampitheatre for next year's conference.

Exceptionally heavy interest in this year's show results from an increasing interest in electronics throughout the Midwest, Napolitan said.

"Much of the research and development which formerly headed West is now staying right here—where almost twice as much electronics business has its headquarters," he said.

New feature of the 1960 conference will be special tours Monday afternoon of Armour and Northwestern, two of the region's research facilities.

Northwestern is planning to open its physiological systems and sampled data control systems labs to the visitors.

Armour will offer them an opportunity to inspect a nuclear reactor, a research computation center, plasmoid and exploding wire facilities, electron and nuclear spin resonance laboratories and, in addition, will explain recent work on antennas.

The 16th annual conference will make its proceedings available to participants at the time of the conference. Bound volumes of the proceedings will include 119 papers selected from the more than 200 submitted in categories covering major aspects of electronics research, development and application.

Digital data transmission gets special emphasis this year, with ten different organizations participating in the preparation of thirteen papers to be presented in two sessions.

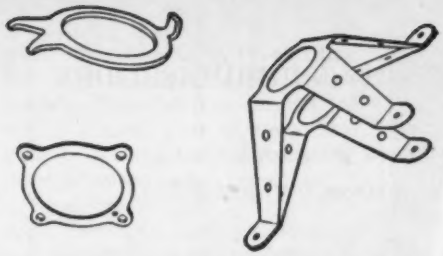
Presentations will cover management computers, automatic sensing and process control from a distance and more efficient use of message trunks. Three of the papers will deal with digital computers, four with their components and two with their application to engineering education. Papers will explain the impact on industry of engineering graduates trained to use computers in the classroom and investigation of computer automation of supermarkets. Robert E. Machol, associate professor in Purdue's school of electrical engineering will describe a system for teaching computer programming to undergraduates within one hour.

Microelectronics is featured in a total of 12 papers to be presented in three sessions.

Microelectronic reductions in scale could permit high system reliability with practical sizes, weights and power consumptions, according to Arthur Stern of the General Electric electronics lab, who is scheduled to open the microelectronics sessions.

Ultra high frequencies will be considered during two sessions featuring six papers, antennas in eight papers organized into two sessions. Other papers will deal with problems in instrumentation for dynamic subjects, Peltier cooling of hotspots, space communication problems during reentry, magnetohydrodynamics, instrumentation and radio astronomy of the solar system.

Next week's conference will also present plaques to nine companies which have displayed their products at 15 consecutive annual shows.



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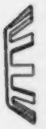

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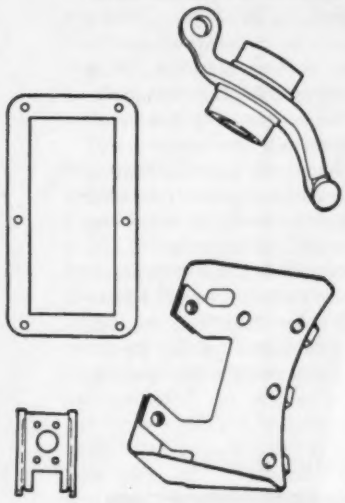

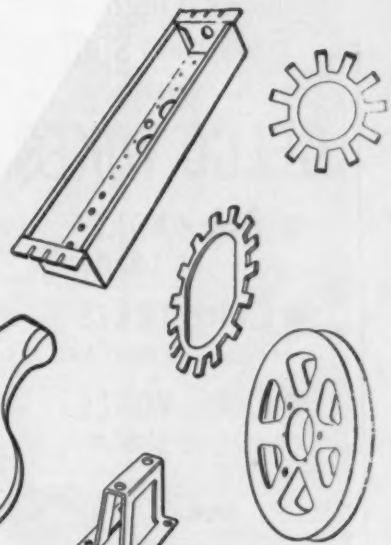

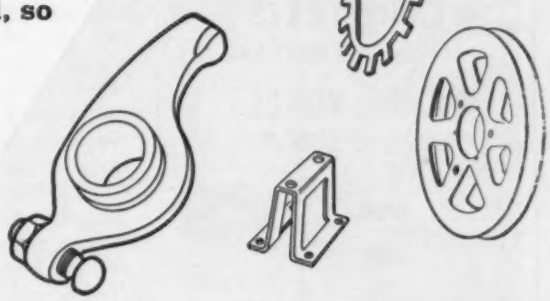

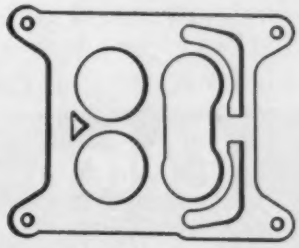

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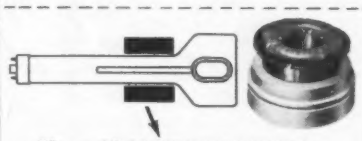

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Space Meet Stresses Communications

Symposium also hears pros and cons on surveillance and navigation satellites

NATIONAL SYMPOSIUM on space electronics and telemetry, meeting in Washington recently, stressed the problems of communications satellite systems. Progress report for the year, as summarized to ELECTRONICS by one scientist attending the three-day meet: "good, solid technical advances."

National Aeronautics & Space Administration, 36 manufacturers and the armed services all set up exhibits at the meeting, showing new products and facilities in space electronics. The technical sessions dealt with space communications, telemetry, electronic (ionic) propulsion, space medicine, and surveillance, navigation and communications satellites.

Included were some oblique references to classified projects, including a discussion of some of the techniques now under study for Air Force's project SAINT (satellite intercept), an inspection satellite which is supposed to keep an eye on unidentified planes.

At a session devoted to satellite communications systems, Hughes Laboratories scientist S. G. Lutz discussed the feasibility of stationary satellites. Eventually, he predicted, there could be a large number of stationary satellites sharing the spectrum (Bell Labs has proposed a network of about 50 satellites in stationary equatorial orbits). Minimum spacing would depend on the antenna beamwidths at the ground terminals, and on the ability of groundbased antennas to resolve one satellite from the one beside it.

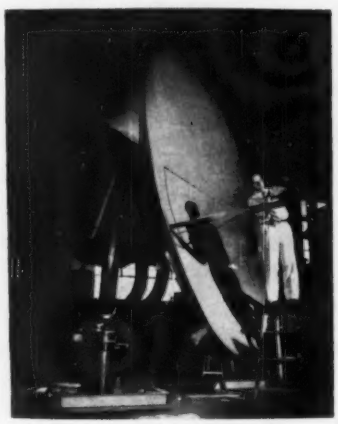
Lutz said he did not favor passive satellites, such as Echo I, because of the high cost of the complex ground installations. He envisions instead a large number of low-cost ground stations sharing a high-cost active satellite capable of relaying information on command.

Other space experts mention that stationary satellites are still some time in the future. Success of active satellite programs will depend on more efficient guidance, control and launching equipment. Problem areas in the eventual communications system from the standpoint of electronics include interference control, crucial if the satellite systems are to coexist peacefully with present radio services. Clear channels, Lutz pointed out, would mean dispossessing prior users, and if satellites need clear channels it will be a major impediment to public acceptance.

Broadbanding is another problem for both antenna systems and circuitry. Each satellite must cover the sum of its earth-terminal bandwidths. It is possible to split the total band into narrow slices for electronic equipment, but that would mean multiplying the equipment, perhaps equipping the satellite with multiple antennas.

A "synchronized" satellite system was described in a paper prepared by a group of scientists from the astroelectronics division of U. S. Army Signal R&D Labs. The satellite would be thrown into a 24-hour equatorial orbit 22,300 miles up, would have the same orbital period as the earth's rotational period,

Long-Range Radar



Raytheon has a $6-million contract to produce and install eight additional long-range air traffic control radars for FAA

would thus appear to be standing still over one spot on the earth's surface. Principal requirements for such a satellite right now are more reliable electronic components and more advanced rocket technology.

New concepts and techniques in areas including coding, recording and demodulation are beginning to permit a flexible approach to space telemetry, according to L. L. Rauch, professor of instrumentation engineering at the University of Michigan. Other industry spokesmen commented that efficient modulation and demodulation schemes might reduce transmitter power requirements from 500 w to 5 w or less. Various orthogonal coding and decoding methods are among techniques that are being explored.

E. Richtin of CalTech's Jet Propulsion Labs told the meeting that the one application in which codes might be worthwhile is for very narrow bandwidth command or narrowband precision telemetering channels in which minimum error rate for minimum signal power is the goal and channel efficiency is not a significant criterion.

One session of the symposium witnessed a lively discussion on the merits of the Navy's Transit navigation system. R. B. Kershner of Johns Hopkins' Applied Physics Lab presented a paper which said that the Navy intends to set up a worldwide navigational aid using earth satellites. Two developmental Transit satellites have been successfully orbited, he pointed out, and the system should be completed by 1962. Two sets of transmitters and two sets of frequencies in the Transit IIA satellite have permitted measurements of the refraction effect. Kershner remarked that calculations based on measurements from all four frequencies mutually support each other, ensuring that current data are reliable and giving substantial support to the basic idea of the system.

C. C. Wan of Hughes Aircraft countered that it is time to make an objective evaluation of the value a satellite system such as this one would have in providing positional data to ships and airplanes. Wan's paper points out some key factors that must be resolved before a navigational system of satellites can be fully operational in the sense that loran or a sextant is operational.

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Computer Controls Tv Switching

WASHINGTON — Developments in tape recording, automation, solid-state rectifiers and measurement techniques were discussed here recently at a two-day symposium of IRE's Professional Group on Broadcasting.

Application of a digital computer to television automatic switching control is under development for CBS, according to engineer Adrian B. Ettlinger. The system should be operational by Jan. 1, 1961. A digital computer, costing about $50,000 and able to store about 2,000 events, will probably be used. Network stations can adapt the computer to their needs.

R. M. Brockway, WFBM-AM-FM-Indianapolis, Ind., reported that this station's operations are almost entirely automatic. With the exception of live news and weather, WFBM-FM is programmed with prerecorded tapes on an 18-hour daily schedule.

An automatically timed program logging system has also been devised. An electric time stamp indicates the starting time of each block of prerecorded material. The station has applied to FCC for permission to use the logger.

A video tape system component, called Amtec (Ampex Time Element Compensator) and developed by Charles Coleman of CBS, was described by Donald MacLeod of Ampex.

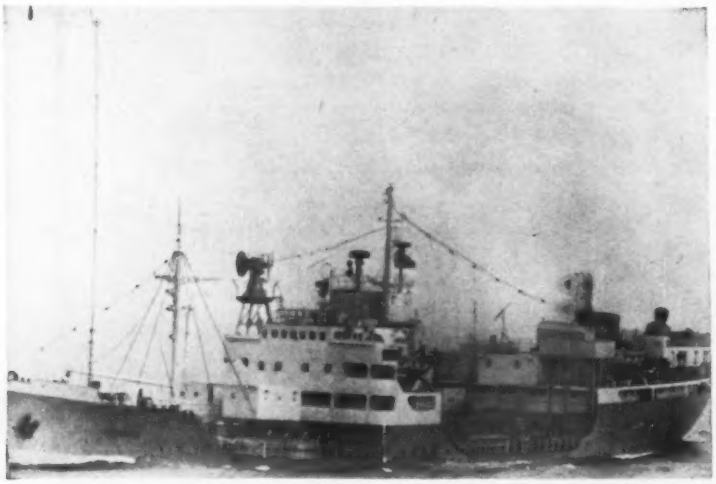
The device automatically compensates for variable recording conditions that could cause geometric distortions in the picture. Engineering prototypes have included compensation capabilities within one microsecond.

Because of the necessity for conformance to FCC signal specifications, one microsecond is likely to be the upper limit of permissible correction. The compensator is said to cut operating discrepancies nearly to zero.

The Amtec, in conjunction with an intersync synchronizer, enables the tape recorder to be absolutely synchronized to the station sync generator, MacLeod said.

The intersync tv signal synchronizer was described by Harold V. Clark of Ampex. It is a high-accuracy servo control system which gives an improvement over previously obtainable synchronization and reduces error by a factor of 50. Phase control of the rotating video head drum to within one minute of arc, while it is rotating at a nominal 14,400 rpm, is possible, he said.

Tracking Soviet Man in Orbit?



Rumors that Russia already had—or soon would—put a man in orbit gained force with the arrival of this Soviet range instrumentation ship, Kokand, in the North Central Atlantic, and other similarly equipped ships in the Central Pacific

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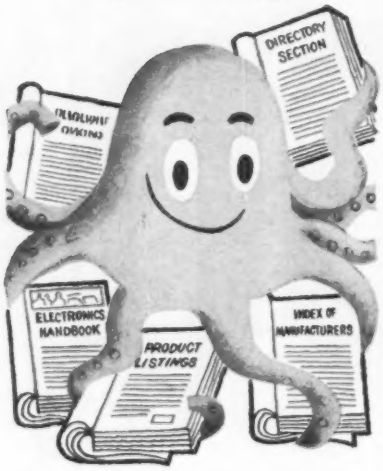

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Space Probes Hunt for Radiation

RADIATION MEASUREMENT was the theme of recent space probes.

The nuclear-emulsion recovery vehicle (NERV) traveled 1,200 miles up on a 62-ft Argo D-8 research rocket. It carried a stack 3 in. in diameter and half an inch long comprising 25 layers of a radiation-sensitive emulsion. The emulsion was exposed from 300 mi. up to 1,200 mi. to take measurements in the Van Allen belts.

Capsule also contained a tiny bit of living matter—mold spores—which will allow scientists to estimate the effect of Van Allen radiation on living and reproducing processes.

Some 36 minutes after launch the 83-lb GE-designed capsule parachuted into the Pacific 1,200 miles southwest of the launching pad at Pt. Arguello, Calif. To facilitate recovery—vital since the nuclear-emulsion measurements cannot be telemetered to earth—the parachute was radar-reflective and the NERV capsule threw out chaff on the way down. Other aids used were a high-intensity strobe light, a radio beacon and fluorescein dye markers.

Later, the Air Force launched its 40-ft Blue Scout rocket from Canaveral in a test of the rocket itself, with payload operation secondary. The 32.8-lb payload contained instruments to probe radiation up to 16,600 miles out from the earth. The Blue Scout may be part of the long-range program to determine the feasibility of detecting high-altitude nuclear bursts, proved otherwise undetectable by the U. S. Argus project in 1958.

ELECTRONICS also learned last week that airborne linear accelerators may be used by USAF to simulate certain aspects of high-altitude nuclear detonation. Design studies completed by Aeronutrionics envisage missile-borne linear accelerators with energy range between 100 Kev and 2 Mev. At these levels, accelerated electrons will simulate the beta radiation from nuclear explosions. The linacs would not need heavy vacuum equipment if operated at the outer fringe of the atmosphere, so total payload could be held to 200 lb. Overall program will include tests to determine D-layer depletion in the ionosphere.

Automatic Controls Needed to Fight Foreign Inroads

CLEVELAND—INCREASED ATTENTION to developing electronic controls and equipment to produce goods cheaper and faster to fight increasing competition from abroad was shown by papers, questions and corridor talk at the Ninth Industrial Electronics Symposium here.

The two-day conference, sponsored by the national PGIE of IRE and the Cleveland sections of both IRE and AIEE, produced more than 15 papers covering measuring devices, data handling and process control.

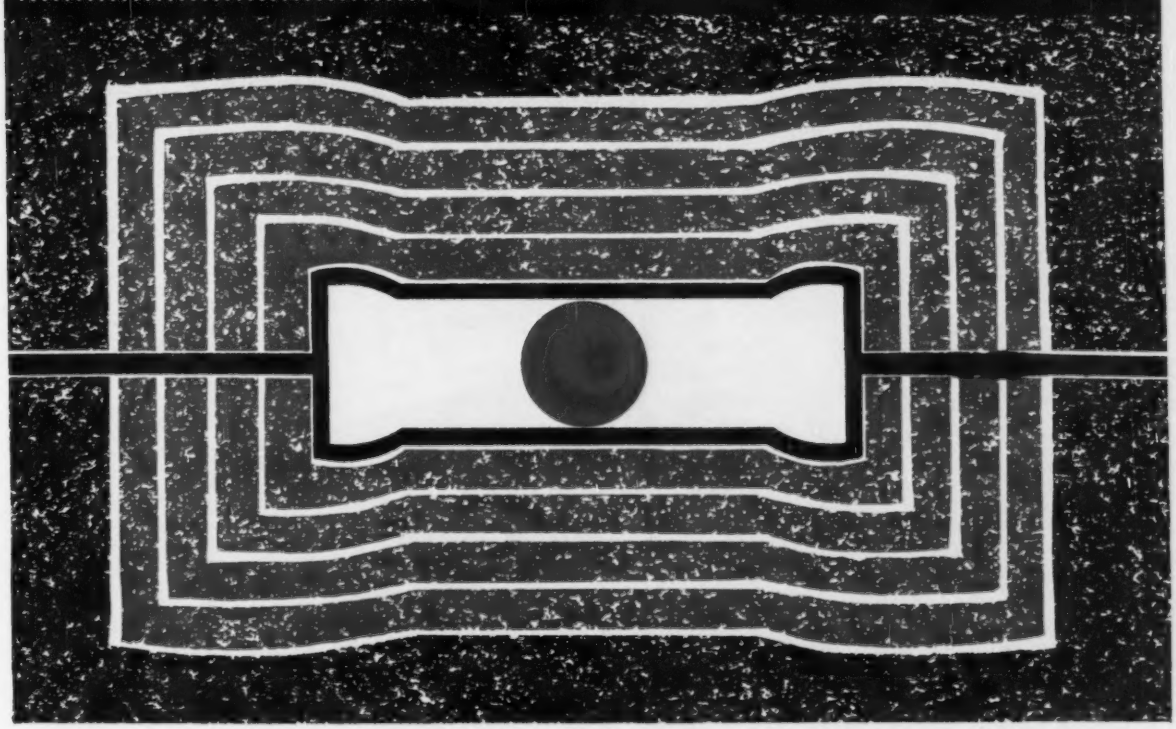
Conferees agreed efficient automated processes in rebuilt European factories were spurring their industry to greater achievements in U. S. plants. This subject was discussed at lunch on the first meeting day by R. W. Barnitz, Jones & Laughlin Steel Corp.'s chief electrical engineer.

The use of a self-triggering spark gap as a simple crowbar at the output of a high voltage d-c power supply to protect the load in case of load failure was described by Victor Wouk of Electronic Energy Conversion Corp. of New York. This self-triggering spark gap is said to have more reliability and fewer voltage limitations than thyratrons. Wouk described applications of the spark gap in the protection of ultrahigh power vacuum tubes from destructive internal arcing. The system itself, consists of three metal spheres arranged as a triggered spark gap. When the load fails, capacitive coupling drives a triggering sphere that fires the entire protective gay system.

A new storage medium for data-handling was described by H. L. Lester of GE. It is a thin thermoplastic film on which digital data can be written at densities of millions of bits per square inch and at rates of megabits a second.

IRC POWER RESISTORS

if it's news, expect it first from IRC



350° Hot Spot—125° Ambient

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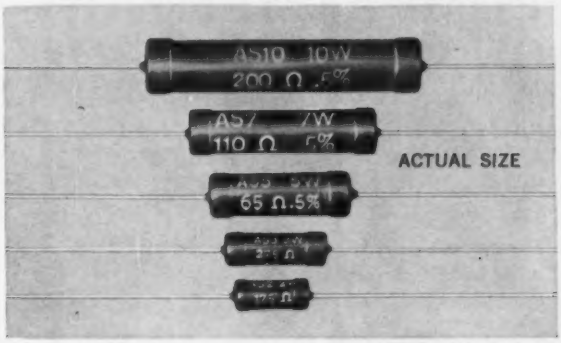
Write for Bulletin AE-18, International Resistance Company, 401 N. Broad St., Philadelphia 8, Pa.



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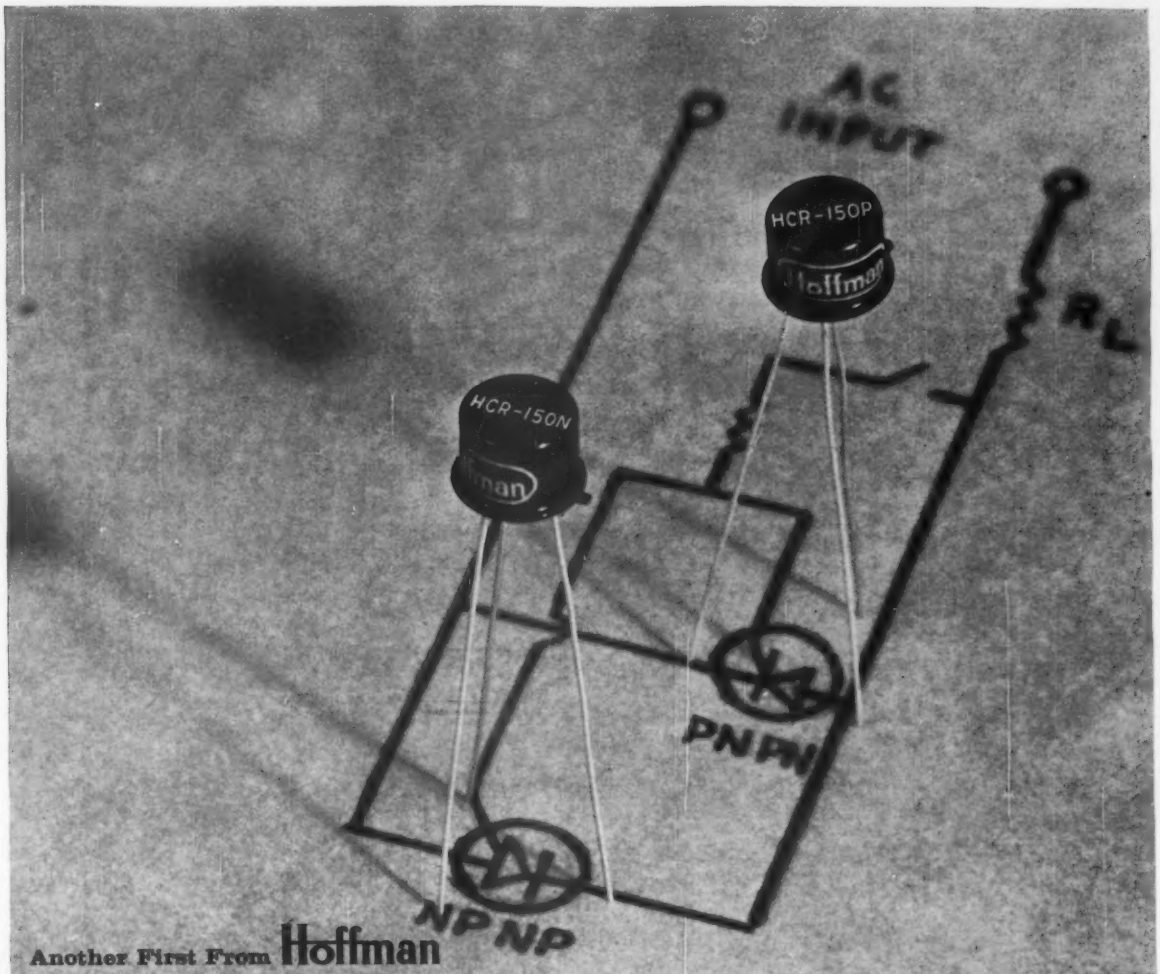

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HCR-100P	2N1506	120	2	100	1.4
HCR-150P	—	180	2	150	1.4
HCR-200P	2N1507	240	2	200	1.4
HCR-300P	2N1508	360	2	300	1.4
HCR-400P	2N1509	480	2	400	1.4
NPNP—1 AMP @ 80°C[1]					
HCR-30N	—	30	2	30	1.4
HCR-50N	2N1500[4]	60	2	50	1.4
HCR-100N	2N1506[4]	120	2	100	1.4
HCR-150N	—	180	2	150	1.4
HCR-200N	2N1507[4]	240	2	200	1.4

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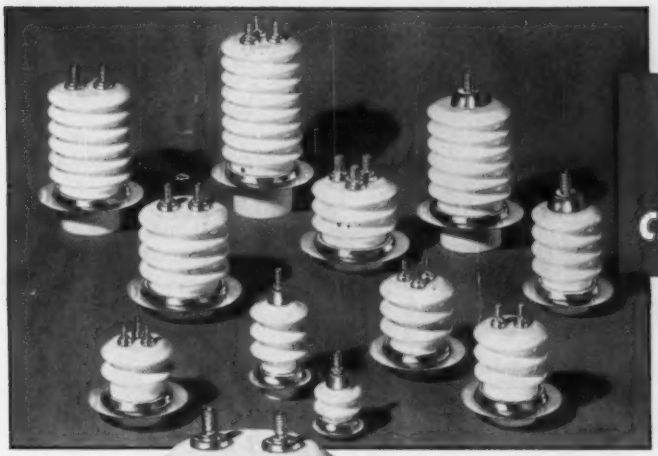

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MEETINGS AHEAD

Oct. 9-14: American Institute of Electrical Engineers, AIEE, Fall General Meeting, Morrison Hotel, Chicago.

Oct. 10-12: National Electronics Conf., Hotel Sherman, Chicago.

Oct. 11-14: Audio Engineering Soc., Annual Convention, Hotel New Yorker, New York City.

Oct. 13-14: Engineering Writing & Speech, Annual Symposium, PGEWS of IRE, Bismark Hotel, Chicago.

Oct. 14: Engineering For Reliability Conference, PGRQC of IRE, Cooper Union, New York City.

Oct. 14-15: Quality Control Conf., ASQC, Broadview Hotel, Wichita, Kan.

Oct. 16-22: High Speed Photography, Soc. of Motion Picture and TV Engineers, Sheraton Park Hotel, Washington, D. C.

Oct. 17-19: Adaptive Control Systems Symposium, IRE, Garden City Hotel, Garden City, N. Y.

Oct. 18-20: Battery Symposium, Ministry of Aviation, S.R.D.E., The Pavilion, Bournemouth, England.

Oct. 19-26: International Congress & Exhibition for Instrumentation & Automation, INTERKAMA, Dusseldorf, Germany.

Oct. 24-26: Aero & Nav. Elec. Conf. PGANE of IRE, Lord Baltimore Hotel, Baltimore, Md.

Oct. 26-27: Computer Applications Symposium, Armour Research Foundation & Illinois Inst. of Tech., Morrison Hotel, Chicago.

Oct. 26-28: Non-Linear Magnetics and Magnetic Amplifiers, AIEE, PGIE of IRE, AIEE, Bellevue-Stratford Hotel, Philadelphia.

Oct. 27-28: Magnetodynamics, Engineering Applications, Engineering Institutes, University of Wisconsin, Madison, Wis.

Oct. 27-28: Electron Devices Meeting, PGED of IRE, Shoreham Hotel, Washington, D. C.

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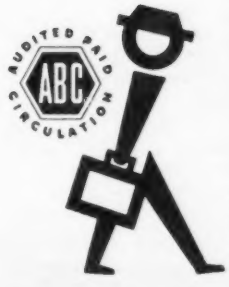

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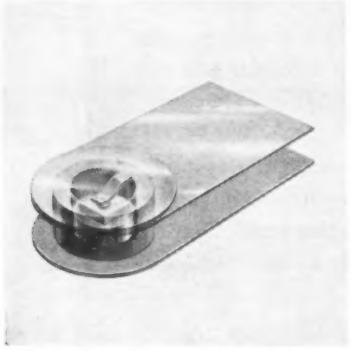

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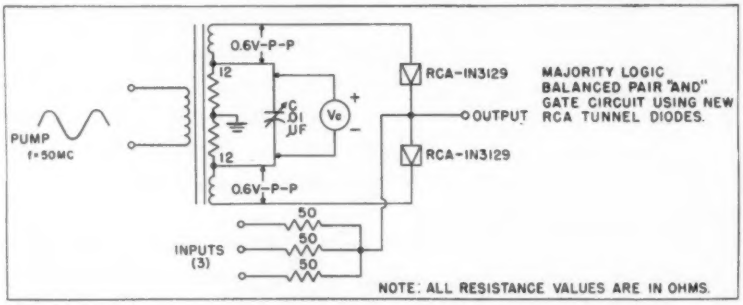
NEW RCA TUNNEL DIODES

Type	I_p (Ma)	I_p/I_v Ratio (min)	Capacitance (C), uuf (typ)	(max)	Material
1N3128	5 ±5%	8:1	7	15	Ge
1N3129	20 ±5%	8:1	10	20	Ge
1N3130	50 ±5%	8:1	12	25	Ge
1N3138	50 ±5%	20:1	10	30	Gallium Arsenide

For additional information on high-performance, low-price RCA Tunnel Diodes, call your RCA representative. For further technical data write RCA Semiconductor & Materials Division, Commercial Engineering, Section J-19-NN-1, Somerville, N. J.



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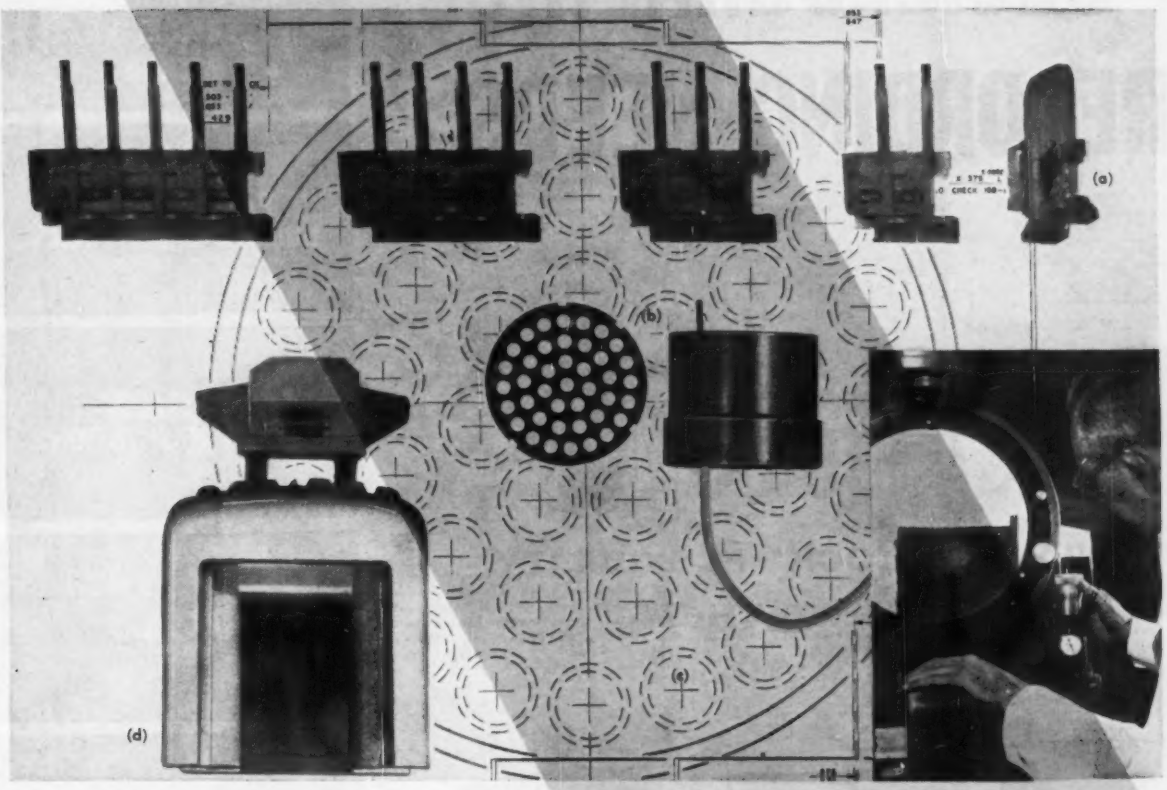

(a) A series of crab locks molded from Nylon.
(b) Electrical connectors for making and breaking as many as 41 electrical circuits at one time are used in missile tracking equipment.
(c) Comparator chart in background enlarges connectors 10 times and checks the accuracy of all holes and insets.
(d) Pick-up head for stereophonic record player. This is a complicated but very small part (one third the width shown) in which three insets are molded into the head.

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NAME YOUR OSCILLOGRAPHIC RECORDING NEEDS

INPUT CHARACTERISTICS

FREQUENCY RESPONSE RANGE . . . RECORDING METHOD

PACKAGING . . . NUMBER OF CHANNELS

LARGE-SCREEN VISUAL PRESENTATION

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Model 297 2-channel recorder, rack mount in 10½" space or portable housing.

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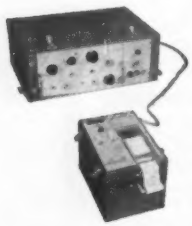
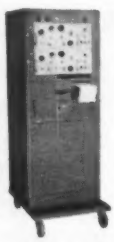
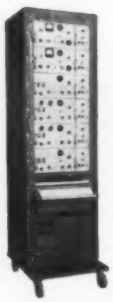


MODEL 151

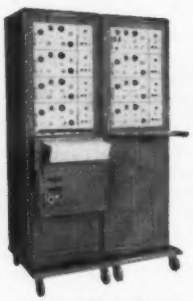


MODEL 152

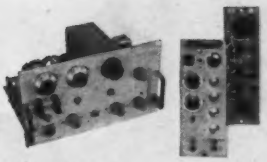
MODEL 154



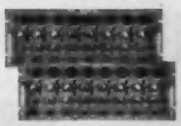
MODEL 156



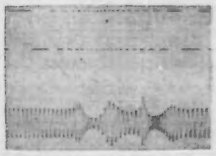
MODEL 158

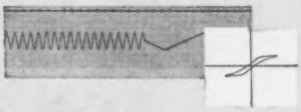


Interchangeable, plug-in preamps for "850" systems include Carrier, Phase-Sensitive Demodulator, DC Coupling, Low Level . . . for "350" systems, all "850" types plus 400 Cycle Frequency Deviation, Logarithmic types . . . for "150" systems, all "350" and "850" types plus AC-DC, AC Wattmeter, RMS Volt/Ammeter, Frequency Meter, Stabilized DC types, and Triplexer 3-channel electronic switch.



Single-chassis, 6- and 8-channel amplifiers for "950" systems include high and low gain general purpose types . . . for "650" systems and optical oscillographs of other manufacturers, a 6- or 8-channel medium gain amplifier.





From DC to 150 cps with most Sanborn systems which produce inkless, heated stylus recordings in true rectangular coordinates . . . up to 5000 cps with new optical system using ultraviolet-sensitive paper. *Optical X-Y Recorder* has 2500"/sec. writing speed, immediate readout.

Sanborn "building block" units give you extremely wide packaging flexibility: "150" amplifiers and recorders can be separately housed or combined in mobile cabinets . . . "350" preamps may be used alone or in a system . . . "850" and "950" systems can have up to 16 channels in a single cabinet . . . optical 5000 cycle recorder can be housed with X-Y recorder, etc. All Sanborn multi-channel recorder assemblies and 350, 650, 850 & 930 amplifier modules fit standard 19" racks.

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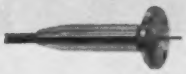
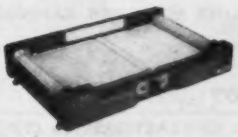
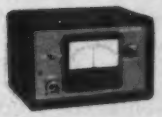




Complete Sanborn equipment for your oscillographic recording needs includes a variable speed *Chart Viewer . . . Servo Monitor Phase Shifter . . .* "150" Series *Wide Band Driver Amplifier . . .* a *Monitor Meter . . .* 4- to 32- channel *Event Recorders with Transistor Driver Amplifiers.*



See how Sanborn oscillographic recording building-block flexibility can provide the most suitable equipment for your needs. Ask your Sanborn Sales-Engineering Representative — offices in principal cities throughout the United States, Canada and foreign countries.

Economical 8-channel "950" high gain, general purpose system.

Model 958-16 Complete 16-channel system with amplification . . . cabinet or rack mounting.

6- or 8-channel "850's", min. panel space.

Model 650 1- to 24-channel optical system, DC to 5000 cps.

Model 670A High speed (100 cps) optical X-Y recorder.

Simplified 6- or 8-channel system, 5 volts full scale.

6- or 8-channel "350's", DC to 150 cps.

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ABSOLUTE MAXIMUM RATINGS

Storage Temperature	−65°C to +100°C
Collector Voltage, V_{CES}	−15 volts
Total Device Dissipation at 25°C	60 mw

ELECTRICAL CHARACTERISTICS (T=25°C)

	Min.	Typ.	Max.	
Static Characteristics				
Collector Cutoff Current, I_{CBO} (V_{CB} = −5v)		1.0	3	μa
DC Current Amplification Factor, h_{FE} (V_{CE} = −0.5v, I_C = −10 ma)	50	90	200	
Base Voltage, V_{BE} (I_C = −10 ma, I_B = −0.5 ma)	0.29	0.33	0.36	volt
Collector Saturation Voltage, V_{CE} (SAT) (I_C = −10 ma, I_B = −0.5 ma)	.09	0.12	0.16	volt
High Frequency Characteristics				
Output Capacitance, C_{ob} (V_{CB} = −3v, I_E = 0, f = 4 mc)		1.9	2.5	μμf
Input Capacitance, C_{ib} (V_{EB} = −1v, I_C = 0, f = 4 mc)		6.0	10	μμf
Gain Bandwidth Product, f_T (V_{CE} = −5v, I_E = 7 ma)	320	450		mc
Switching Characteristics				
Rise Time, t_r (β_C = 10)		13	18	mμsec
Hole Storage Factor, K'_s		39	50	mμsec
Fall Time, t_f (β_{CO} = 10)		10	18	mμsec

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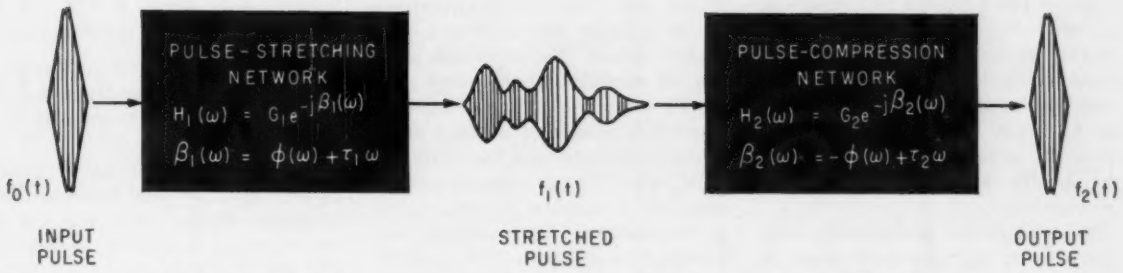

FIG. 1—Basic instrumentation of pulse compression shows the two all-pass networks, where $G_1G_2 = 1$

Getting High Range Resolution With Pulse Compression Radar

High range resolution is ordinarily achieved by reducing the pulse length, requiring an increase of peak pulse power. By transmitting a stretched pulse and compressing the received pulse, a shorter pulse with high effective peak power is obtained

By GUNNAR P. OHMAN, Radar Division, U. S. Naval Research Laboratory, Washington, D. C.

AS A RULE the easiest and most direct method for achieving high range resolution in a radar system is with short pulses. Radar range-resolution capability is about half a foot for every nanosecond of pulse length. Maximum range of detection, on the other hand, depends on the average power transmitted, which is directly related to pulse energy. Both high range-resolution and long range of detection are desirable attributes but tend to be mutually exclusive in a conventional pusle-radar system. When the pulse length is reduced to enhance resolution, peak pulse power must be increased to maintain pulse energy, and this is possible only so long as the peak-power capability of the transmitter is not exceeded. A reduction in pulse length beyond this point will result in loss in transmitted pulse energy even though the average-power capability of the transmitter is not approached.

Consider a transmitter that has a peak-power capability of one megawatt operating at a prf of 300 pulses per second. For a pulse length of 5 μsec the pulse energy would be 5 watt-seconds and the average power, 1.5 Kw. If the pulse length were reduced to 0.05 μsec, the pulse energy would be only 0.05 watt-second, and the average power, 15 watts. To have the same energy in the 0.05-μsec pulse the transmitter power would have to be increased to 100 megawatts, which is beyond the present state of the art. An extreme case of low pulse energy is found in a radar system that uses an 0.02-μsec, 25-Kw pulse which corresponds to a pulse energy of only 5×10^{-4} watt-second, and an average power of about a watt.

A concept called pulse compression, coupled with the relatively recent development of high-power microwave amplifiers, provides a feasible method for circumventing the high-resolution — short-range dilemma in radar systems. The concept seems to be due to the Germans, E. Huettmann[1] and W. Cauer[2], the latter considering it theoretically. Both R. H. Dicke[3] and S. Darlington[4] in this country have proposed ideas in this field of a

possibly more practical nature for radar purposes. The idea is that the transmitted signal is made to have simultaneously a relatively long time-duration, and a relatively wide frequency-bandwidth. On reception the signal is distorted into a much shorter and consequently higher peak-power pulse by an all-pass network that rearranges the spectral components of the signal as to phase. Greater length makes possible greater energy and wide bandwidth makes possible better resolution.

A transmitted pulse both relatively long in time and great in bandwidth might seem to be a contradiction, especially since it is common practice to relate pulse length, T, to bandwidth, B, by the approximate formula,

$$T = 1/B. \qquad (1)$$

Equation 1, however, has validity only for pulses generally used in radar systems, and this formula really specifies only approximately the shortest pulse-duration (measured usually at the 3-db points) possible for a given bandwidth. It does not necessarily follow that the greater the bandwidth the shorter the pulse. This is brought out in Fig. 1.

The instrumentation of pulse compression for radar is accomplished by two all-pass networks, labeled Pulse-Stretching Network and Pulse-Compression Network in Fig. 1. Quantities $H_1(\omega)$ and $H_2(\omega)$ are network transfer functions. As all-pass networks their transfer function gains, G_1 and G_2 are independent of frequency, ω. Their phase functions, $\beta_1(\omega) = \phi(\omega) + \tau_1\omega$, and $\beta_2(\omega) = -\phi(\omega) + \tau_2\omega$, are designed to be conjugates of each other to within some constant delay. Since group delay, τ_d, is given by

$$\tau_d = d\beta/d\omega = d[\beta_1(\omega) + \beta_2(\omega)]/d\omega,$$

total group delay through the two networks in cascade will be $\tau_1 + \tau_2$ independent of ω, and, thus there is no difference between input and output waveforms except for a relative time displacement. Insofar as each individual network is concerned, the delay is frequency-sensitive and the input and output waveforms will differ although both have the same relative spectral content. By a pulse-stretching network it is possible to phase distort a short, radar-type pulse (labeled Input Pulse in Fig. 1) into a much longer pulse (labeled Stretched Pulse in Fig. 1). Note that phase distortion may introduce both a change in the pulse envelope and an apparent frequency-modulation in the sense that the axis crossings of the carrier are no longer uniformly spaced. The stretched pulse can be amplified to the same peak power as the short input pulse in a power amplifier of a given peak-power capability, and the stretched pulse, which has greater energy because of its greater length, would be transmitted. On reception the stretched pulse is passed through the conjugate network (labeled Pulse-Compression Network in Fig. 1) and the short pulse with all its resolution capability is regained at the output. The pulse-stretching and pulse-compression networks form a pair of matched filters, and the process falls in the broad category of matched-filter theory.

Pulse compression as depicted in Fig. 1 implies a completely linear system. Unfortunately, both the attainment of high pulse energy and good efficiency require that the transmitter be driven to saturation, where it is usually nonlinear. The seriousness of transmitter nonlinearity on system operation depends on the stretched-pulse waveform. For example, narrow, high-amplitude spikes would be clipped by the transmitter with a considerable change in the pulse spectrum and the output of the compression network might differ significantly from the desired compressed-pulse waveform. To avoid clipping and possible degradation of pulse shape, the transmitter would have to be operated in its less efficient linear region, if this is possible. Moreover, the pulse energy would be further limited because the peak pulse power would then be set by the amplitude of the highest peak in the stretched-pulse waveform. However, if the amplitude of the stretched-pulse waveform were constant over the major portion of its duration, transmitter clipping should be less serious and both pulse energy and transmitter efficiency could be enhanced.

For optimum transmitter operation, then, the ideal stretched-pulse waveform is rectangular. Fortunately, this is also a usable one, although it leads to difficulties. The idea of pulse compression is often explained[5] in terms of a rectangular, linearly-frequency-modulated, stretched pulse like the one illustrated in Fig. 2A. Mathematically, the apparent instantaneous frequency, ω, as shown in Fig. 2B, of such a pulse can be represented as

$$\omega = \omega_o + at, \quad -T_1/2 < t < T_1/2,$$

where ω_o is the center frequency of the pulse and a is the rate of frequency modulation.

If the compression network has an incremental group delay against frequency of the same rate but in the opposite sense, as shown in Fig. 2D, for example

$$\tau_d = (\omega_o - \omega)/a + \tau_2, \qquad (2)$$

all the frequency components of the stretched pulse will arrive in phase at the output of the compression network at some particular time with a build-up of peak pulse power that must be balanced by a corresponding reduction in pulse length, since energy is conserved.

Several assumptions have been made that are physically realizable and valid theoretically only as approximations. It is not possible to phase distort a pulse of finite duration into a long, frequency-modulated, rectangular pulse by a finite, linear, passive network; at best the stretched pulse must have a low amplitude tail that theoretically extends to infinite time, and would be gated out in the transmitter. Actually, a linearly-frequency-modulated, rectangular pulse can be generated to a good approximation by active means using a gated, voltage-tuned backward-wave-oscillator; no pulse-stretching network would then be required.

The group-delay characteristic assumed in Eq. 2 for the compression network is negative at certain frequencies, and this is also impossible, but by introducing a sufficient amount of fixed delay, τ_2, into the compression network, the desired delay characteristics can be approximated as a positive quantity over the range of frequencies that encompasses the major part of the pulse spectrum.

If the stretched-pulse spectrum (Fig. 2C) is assumed to be rectangular, and the compression-network delay (Fig. 2D) linear with frequency, the compressed-pulse waveform $f_s(t)$, as given by the inverse Fourier transform, and as

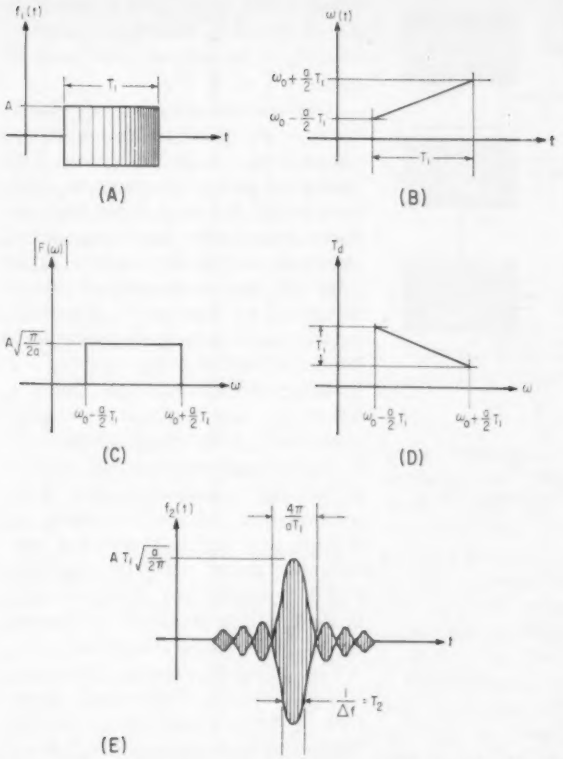

FIG. 2—Pulse-compression scheme shows an idealized linearly-frequency-modulated stretched-pulse waveform (A), stretched-pulse instantaneous frequency (B), idealized pulse spectrum (C), compression-network delay vs frequency (D), idealized compressed-pulse waveform (E)

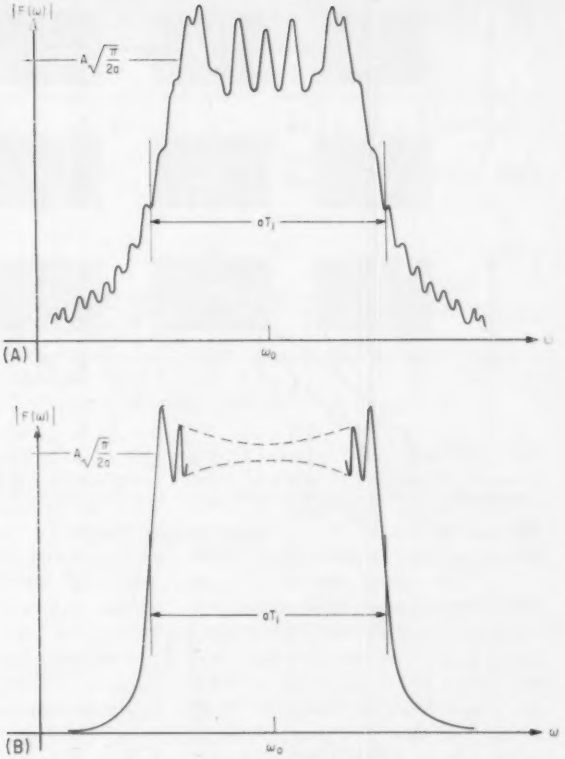

FIG. 3—True spectrum for the nominal compression ratios of 18:1 (A) and 206:1 (B), with amplitude plotted against frequency. A true waveform for the lower figure would show a low-voltage, high-frequency modulation that cannot be drawn at this scale

shown in Fig. 2E, is

$$f_2(t) = 2\left(\text{real part of } \frac{1}{2\pi}\int_{\omega_o - aT_1/2}^{\omega_o + aT_1/2} A\sqrt{\frac{\pi}{2a}}\, e^{j\omega t}\, d\omega\right)$$

$$= \frac{AaT_1}{\sqrt{2\pi a}} \frac{\sin(aT_1 t/2)}{(aT_1 t/2)} \cos \omega_o t. \quad (3)$$

Equation 3 shows that the peak power, P_2, in the compressed pulse is larger than the peak power, P_1, in the stretched pulse, and the compressed-pulse length, T_2, is smaller than the stretched-pulse length, T_1. Let P_2/P_1 be the peak-power ratio, and since the spectrum bandwidth, $B = aT_1/2\pi$, then

$$P_2/P_1 = \left(\frac{AaT1}{\sqrt{2\pi a}}\right)^2 \Big| A^2 = BT_1 = T_1/T_2,$$

where T_2 is taken arbitrarily as $1/B$, and is the 4-db, compressed-pulse length. The time-bandwidth product, BT_1, of the stretched pulse thus corresponds closely to the actual compression ratio and the increase in peak power that results.

The idealized spectrum (Fig. 2C) is not the true spectrum of the stretched pulse (Fig. 2A), but an approximation that improves with increasing compression ratio. The actual spectrum, $F(\omega)$; is given by

$$F(\omega) = \int_{-T_1/2}^{T_1/2} A \sin(\omega_o t + at^2/2) e^{-j\omega t} dt$$

$$= \frac{A}{2j}\sqrt{\frac{\pi}{a}}\, e^{-j\frac{(\omega_o - \omega)^2}{2a}} [C(u_1) + C(u_2) + jS(u_1) + jS(u_2)],$$

where

$$C(u) = \int_0^u \cos \pi u^2/2\, du$$

$$S(u) = \int_0^u \sin \pi u^2/2\, du$$

are Fresnel integrals, and

$$u_{1,2} = \sqrt{BT_1/2}[1 \pm 2(\omega_o - \omega)/aT_1].$$

There is also a similar spectrum at negative frequencies about $-\omega_o$.

Spectrum amplitude is plotted for nominal compression ratios of 18 and 200 in Fig. 3A and 3B, respectively. The latter is not a precise plot because the scale of the graph makes it impractical to include the low amplitude, fine structure that should be superimposed on the curve shown.

A compressed-pulse envelope similar to the $\sin(aT_1t/2)/(aT_1t/2)$ form obtained in the example would be disadvantageous in a high-range-resolution radar system because the sequence of lesser pulses that both precede and follow the main compressed pulse might mask weak targets near stronger ones. The designation of sidelobes is often given to these pulses because of their similarity to the sidelobes of an antenna pattern.

Close analogies exist between pulse-compressed waveforms and antenna patterns. For example, the pattern, $G(\theta)$, resulting from a uniformly illuminated aperture[6] of width W at a wavelength, λ, is given by

$$G(\theta) \sim \frac{\sin[(\pi W/\lambda)\sin\theta]}{(\pi W/\lambda)\sin\theta}.$$

If the width is many wavelengths the pattern at small angles is given approximately by

$$G(\theta) \sim \frac{\sin[(\pi W/\lambda)\,\theta}{(\pi W/\lambda)\,\theta},$$

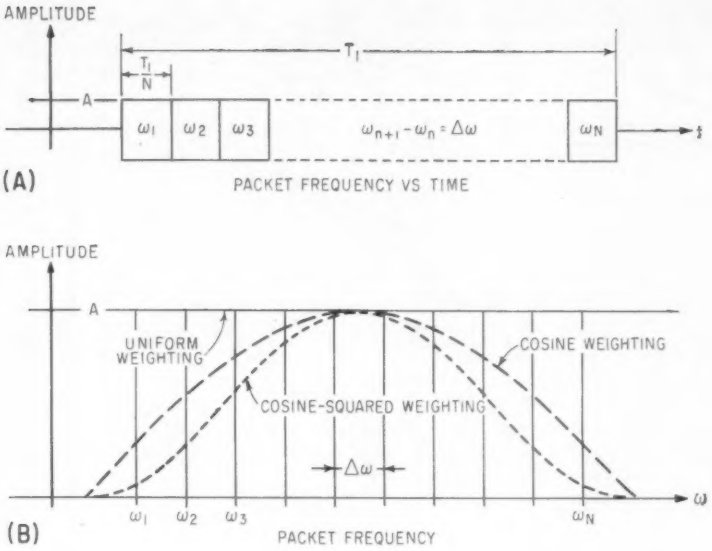

FIG. 4—Stretched pulse frequency-modulated in discrete steps (A), possible frequency weighting functions for sidelobe modification (B), and rectified compressed-pulse envelopes for various weighting functions (C)

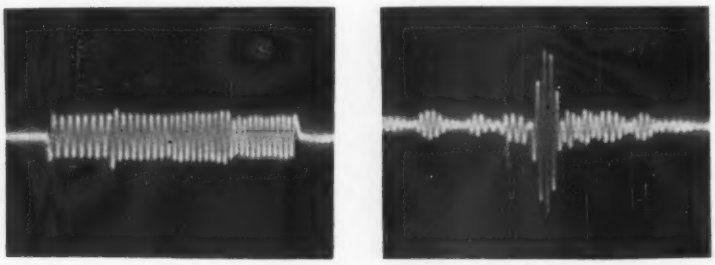

FIG. 5—Stretched pulse (A) and compressed pulse (B) frequency-modulated in discrete steps. No effort was made to control sidelobe amplitude

which is the same form as given by Eq. 3 for the compressed pulse if time, t, is considered analogous to angle, θ.

Antenna sidelobes can be reduced by tapering the illumination at the extremities of the aperture. The analogous procedure in pulse compression is to use a filter that reduces the relative amplitude of the spectrum at the extremities. Possibly the classic example of this is discussed by Kroenert[7,8], who considers a linearly-frequency-modulated stretched-pulse having a Gaussian-shaped envelope. Such a pulse also has a Gaussian-shaped spectrum and is compressible into a nonfrequency-modulated shorter pulse, also Gaussian-shaped, and, consequently, without sidelobes. It is more practical to transmit a rectangular pulse with its approximately rectangular spectrum and to modify this spectrum in the receiver for sidelobe reduction.

The antenna analogy compares a continuously illuminated aperture to pulse compression using a continuously-frequency-modulated stretched-pulse. A narrow-beam antenna array can be formed using spaced, discrete radiators. In pulse compression this would be analogous to a stretched pulse frequency modulated in discrete steps. Such a pulse (Fig. 5A) might be generated using successively gated keyed oscillators, one for each discrete frequency. The corresponding compression network might consist of a bank of tuned circuits with fixed-delay networks to allow the output at each frequency to be summed at the same time. On an idealized basis the summing can be represented as

$$f_2(t) = A \sum_{n=0}^{N} \sin (\omega + n\Delta\omega)\, t$$

$$= A \frac{\sin (N\Delta\omega t/2)}{\sin (\Delta\omega t/2)} \sin (\omega + (N-1)/2\, \Delta\omega)\, t,$$

$$-T_1/2N < t < T_1/2N.$$

The center frequency of the compressed pulse is $\omega + (N-1)/2\, \Delta\omega$ and the quantity, $A \sin(N\Delta\omega t/2)/\sin(\Delta\omega t/2)$, is the envelope function. In order that the compressed pulse have only a single major lobe with no more than one complete cycle of sidelobes, the length of each frequency packet, T_1/N, must be such that the relationship is

$$(T_1/N)\,\Delta\omega = 2\pi,$$

or

$$\Delta f = N/T_1,$$

where Δf is the frequency increment between successive frequency packets in the stretched pulse. The peak amplitude of the compressed pulse is AN, so that the peak power on compression is increased by the factor, N^2. If the compressed pulse length, T_2, is taken as half the time between the first nulls of the compressed pulse envelope, that is

$$N\Delta\omega 2T_2/2 = 2\pi,$$

or

$$T_2 = 2\pi/N\Delta\omega = 1/N\Delta f = T_1/N^2,$$

the compressed pulse is shorter than the stretched pulse by the same factor of N^2.

There are problems associated with the design of a suitable compression network for the discrete delay case. Each of the frequency packets in the stretched pulse, being of finite length, has a $(\sin x)/x$ shaped spectrum, and a certain amount of spectrum overlapping will occur, especially for adjacent pulse packets. If the packet-selecting circuits in the compression network are made narrow to circumvent spectrum overlap, the output pulses must be long, which leads to several major compression-lobes. If these circuits are made too broad, each will respond to several of the frequency packets in the stretched pulse and a separate delay for each frequency packet becomes impossible. A circuit bandwidth on the order of Δf represents a usable compromise. If it were not for the spectrum overlap, each frequency packet in the stretched pulse could be shortened to eliminate the sidelobes in the compressed pulse.

Sidelobe amplitude can also be reduced in discrete frequency-modulation by shaping or weighting the spectrum. Figure 4 shows the effect on compressed-pulse shape and sidelobe amplitude of uniform weighting, cosine weighting, and cosine-squared weighting for $N=10$. The price paid for sidelobe reduction is loss in peak power and a widening of the compressed pulse, which is analogous to loss in gain and a broadening of the beamwidth in the corresponding antenna case. Some

Figure 5 shows photographs taken of a laboratory experiment on pulse compression using a stretched pulse, frequency modulated in discrete steps. Packet frequencies were chosen low enough to show the individual cycles. Examination of the four individual pulse packets which make up the stretched pulse will show that they contain successively one additional r-f cycle, that is, eight, nine, ten, and eleven cycles.

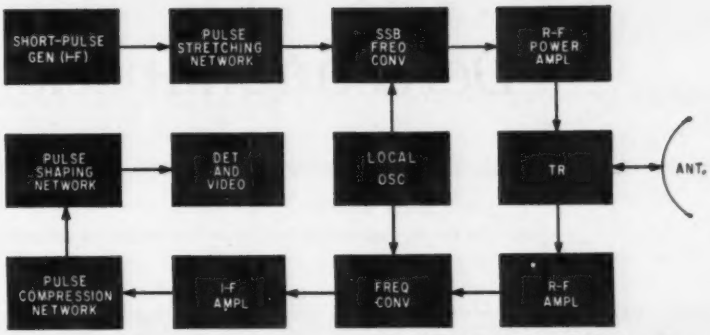

FIG. 6—Block diagram shows how pulse compression might be incorporated into a radar system

Figure 6 is a block diagram showing how pulse compression might be used in a radar system. Pulse stretching and compression would probably be done at an i-f frequency because of practical considerations relating to network synthesis. The stretching and compression networks[7,8] generally consist of many constant-resistance, lumped-parameter, bridged-T sections of a relatively few basic configurations cascaded to approximate the desired delay-characteristics. As low an i-f frequency as is possible, consistent with bandwidth, is usually advantageous because stray capacitance is then less of a problem and the atainable differential delay on a per-network-element basis is higher. Pulse stretching or compression directly at microwave frequencies would require distributed-parameter networks for which synthesis techniques are not so far advanced. Pulse-shaping networks for sidelobe reduction may be incorporated into the compression network. Frequency conversion in the transmitter must be single-sideband so that the transmitted pulse will be frequency modulated in the same way as the stretched pulse is at the i-f frequency. In the receiver, frequency conversion automatically results in only one sideband because the other will not normally be in the passband of the i-f amplifier. Not to degrade receiver signal-to-noise-ratio, receiver gain must be provided ahead of the compression network to compensate for network loss, which was not considered in the theoretical discussion, but may be considerable.

Concern is sometimes expressed about the ability of a pulse-compression radar to resolve targets closer together than the range equivalent of the transmitted pulse length because energy reflected from such targets arrives at the receiver partially overlapped. Resolution capability must be that equivalent to the compressed pulse length, the compression network separating the energies from discrete targets. Assuming a linear system this conclusion can also be reached by imagining the pulse-compression network to be transferred from the receiver to the transmitter immediately following the pulse-stretching network. The transmitted pulse would then have the compressed-pulse length and the corresponding range-resolution capability. To a first approximation, a radar system using pulse compression is, therefore, equivalent to a conventional radar system using a transmitted-pulse length equal to the compressed-pulse length.

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Detecting Muscle Potentials in

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TO WHAT DEGREE is defective jawbone growth the result of heredity or abnormal muscle function? The instrument to be described should help find the answer to this and other questions. In research studies of muscle function in humans, electrodes can be placed on the skin overlying the muscles or needle electrodes can be directly inserted in the muscles. Such methods of electrode placement will not work when studying muscle function in animals, since an unanesthetized and unrestrained animal would soon damage or displace the electrode probes.

A system has been devised to study muscle activity in unanesthetized dogs. It consists of two parts: one that is implanted in the animal, and an exterior portion that links the animal to a recorder. The implant (Fig. 1) consists of a pair of electrodes that are placed in the muscle, a transistor amplifier, coil and rectifier. The exterior part of the system includes an oscillator connected to a coil. This external coil is superpositioned over the internal one and taped to the animal's neck (Fig. 2). The field of the internal coil absorbs energy from the external coil driven by the oscillator. The degree of absorption is modulated by the output of the internal amplifier, this output being modified by the muscle potentials. The envelope of the voltage of a second exterior coil is recorded, providing a graphic record of the activity of the muscle.

The magnitude of the voltage generated when a muscle contracts depends upon the number of muscle fibers involved. These voltages may vary from 50 to 5,000 microvolts. The voltage detected is determined in part by the geometric relation of the electrodes to the active muscle fibers.

Figure 3 shows the implanted and external units. Oscillator Q_1 operates at approximately 50 Kc. The oscillator, a modified Hartley, has a tuned coil in its collector circuit coupled to a feedback coil in its base circuit. The feedback coil is also connected to the base of Q_2, a buffer amplifier. The output of Q_2 passes to an external coil, L_1 of T_2. The potential induced in coil L_2 of T_2 is rectified by diode D_1, producing a d-c voltage that passes to the galvanometer and the output monitor.

External coils L_1 and L_2 are positioned so that internal coil L_3 is within their magnetic field. Coil L_3 absorbs energy from coil L_1. The voltage induced in coil L_3 is rectified by diode D_2, thus providing power for transistor Q_3. Since the base of Q_3 is connected to the muscle, the potential generated when the muscle becomes active determines the base bias of Q_3. To stabilize the base circuit of Q_3 against temperature change a constant base bias must be maintained. Since the bias of the implanted transistor has to be adjusted before it is placed in the animal, the change from room temperature to body temperature must be taken into account because of the operation of the transistor. Diode D_3, in series with resistor R_1, is connected to D_2. The voltage drop across D_3 varies with the temperature to compensate for the effect of the temperature change on Q_3.

The potential generated by the muscle acts on the base of Q_3, thus modifying the collector current of Q_3. The collector current of Q_3, which is derived from the potential induced in coil L_3 by the field of coil L_1, acts as a partial short circuit across coil L_1. Therefore, the field of L_1 varies with the muscle potential. Thus the potential generated in the external pickup coil (L_2) is modulated. The potential induced in this coil is rectified. The envelope of this potential acts on the base of Q_4 to provide an output voltage across the collector of Q_4, which follows the muscle potential. The collector potential is picked up across resistor R_2, which is in series with the galvanometer, and fed to a recorder. Potentiometer R_3 adjusts sensitivity.

This work was supported in part by the National Institute of Dental Research.

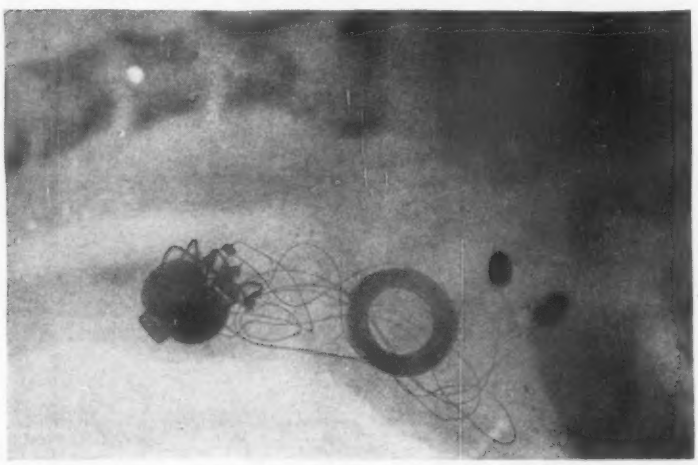

FIG. 1—X-ray photograph of implant. The two electrodes are at the right

Unanesthetized Animals *Implanted probe of research instrument includes an amplifier that does not require an internal power supply*

FIG. 2—This dog has a probe implanted in the masseter muscle of the jaw

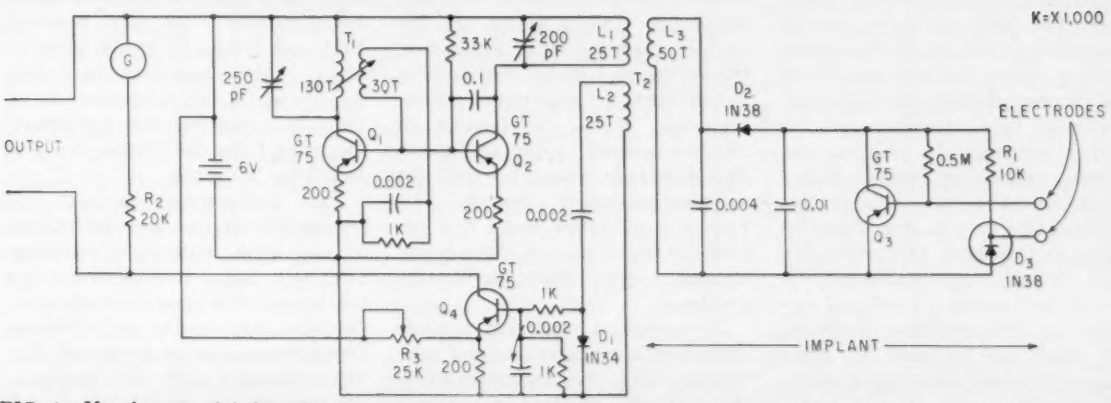

FIG. 3—Muscle potential detection system. External unit is at left-hand side, implanted section at right

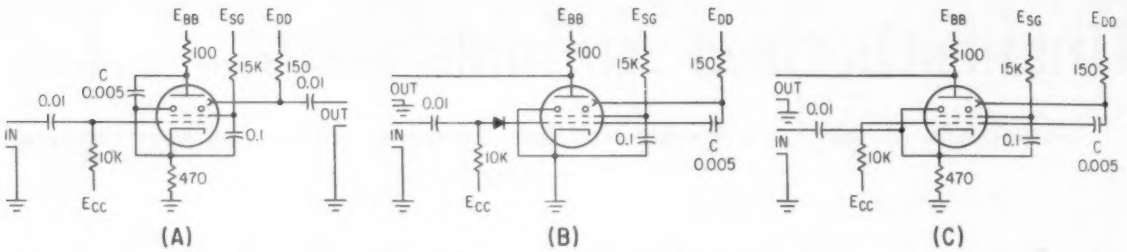

FIG. 1—Secondary-emission pentode trigger circuits: with positive feedback from plate to cathode (A); with positive feedback from dynode to grid (B); and for triggering with negative pulses (C)

How to Use the Secondary-Emission Pentode

Unique properties of the secondary-emission pentode, important in high-speed, short-duration pulse work, make this tube potentially useful in solving vacuum tube circuit problems

By E. J. MARTIN, JR., Midwest Research Institute, Kansas City, Missouri

SECONDARY-EMISSION pentodes represent an important contribution to nanosecond pulse techniques.[1]

Although many persons who have a working knowledge of millimicrosecond pulse circuits might find it difficult to justify the designation of this or any other device as the most important, the secondary-emission pentode has done much to advance the state-of-the-art in high-speed, short-duration pulse work. The tube has made possible triggering circuits that have shorter starting delays, better repeatibility and shorter recovery times than gas-discharge tube circuits used for similar purposes. In addition, the secondary-emission pentode makes it convenient to use regenerative feedback for generating fast-rise pulses at extremely fast repetition rates. Finally, the secondary-emission pentode can produce signal amplification without phase inversion, and thus can be used in some unique, balanced, distributed amplifier circuits.

Three types of secondary-emission pentodes are avaliable commercially—the Philips EFP-60; the E.M.I. Z-319; and the recently announced CBS type 7548.

We do not discuss or compare specific characteristics of these different tube types here, but deal with the general properties of the secondary-emission pentode class of vacuum tubes and demonstrate some unique properties by considering a few circuits which are frequently used for pulse generation, triggering and pulse amplification.

Engineers not engaged in the development and/or application of millimicrosecond pulse techniques should become acquainted with the secondary-emission pentode. Its general capabilities make it a potentially useful tool in the solution of some specific electronic circuits problems.

The secondary-emission pentode comprises a high-vacuum, r-f pentode modified by a secondary-emission cathode, or dynode, situated between the suppressor and the plate. This dynode is operated at a potential intermediate between cathode and plate potentials. Its location is such that primary electrons which traverse the first part of the pentode structure (from cathode through suppressor) impinge upon the dynode rather than traveling directly to the plate.[2] The dynode is made of, or sensitized with, a material that has a high secondary-emission ratio,[3] usually in the range between four and seven. Since the plate is at a higher potential than the dynode while the suppressor is at cathode potential, the secondary electrons from the dynode are collected by the plate.

This arrangement greatly increases the overall transconductance of the tube without introducing relatively large interelectrode capacitances. The secondary-emission pentode may show an effective transconductance in excess of 20,000 micromhos with input and output capacitances of only 10 pf and

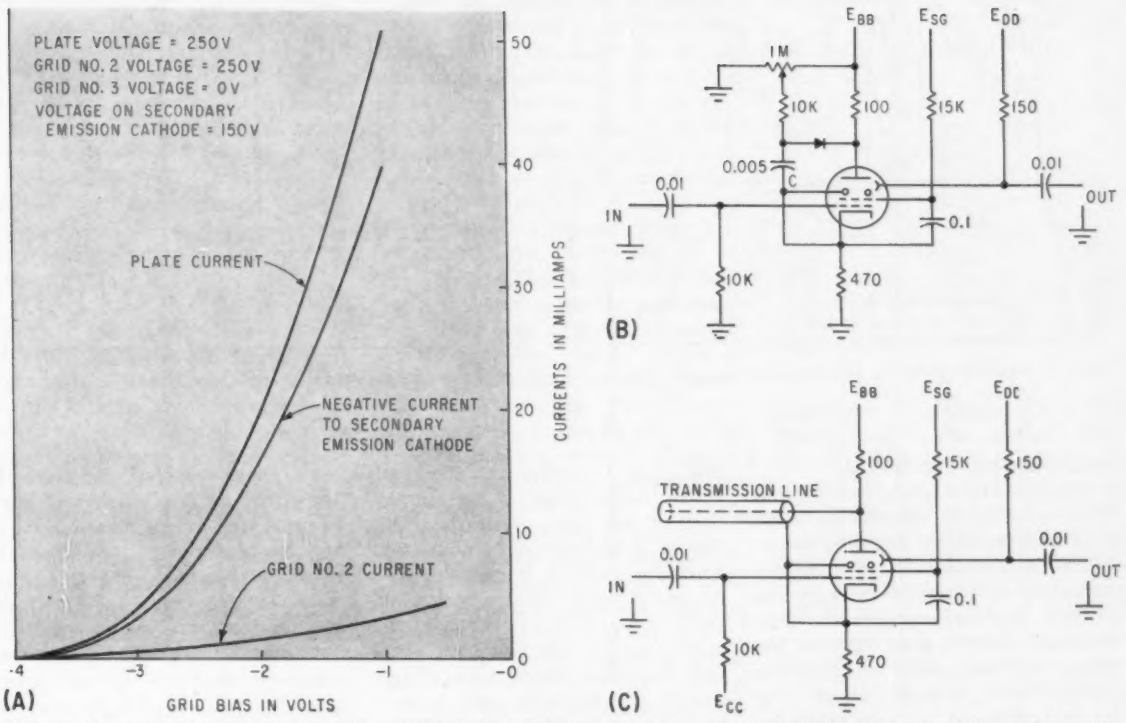

FIG. 2—Transfer characteristics of the EFP-60 (A); trigger circuit or pulse height discriminator (B); and a variation of the feedback circuit in a secondary-emission pentode trigger (C)

5 pf, and a grid-to-plate capacitance approximately three orders of magnitude smaller. Thus, in the design of cascaded, class-A amplifier stages, the secondary-emission pentode is of interest since it has a gain-risetime factor that compares favorably with those of other high-frequency pentodes.

Another feature arising from the novel arrangement is that since the dynode emits electrons at a greater rate than it receives them, there is an effective positive current flow out of the dynode. Except for the slight delay due to electron transit time, this dynode current is in phase with the grid signal. Consequently, an amplified, in-phase voltage will appear across a load impedance in the external dynode circuit. Besides amplification without phase inversion, this positive dynode current, along with the fact that both the dynode and plate currents are several times larger than the cathode current, leads to the possibility of using positive feedback to generate fast-rise pulses.

The ways in which the properties of the secondary-emission pentode can be employed to advantage are most easily explained by considering a few typical secondary-emission pentode circuits.

Consider triggering and pulse generating circuits.[4, 5, 6] A regenerative, secondary-emission pentode trigger circuit is shown in Fig. 1A on p 60.

In the quiescent state, the control grid potential is adjusted to a value that is sufficiently negative to just maintain the tube cutoff. The cathode is at ground potential, the plate is at some potential E_{BB} volts above ground and the dynode is at an intermediate potential E_{DD}. Since the tube is just cutoff, even a small positive-going signal on the grid will liberate some cathode electrons. When these electrons impinge on the dynode, secondary emission occurs and the plate collects an electron current several times larger than that which originally left the cathode. Because it is emitting electrons, the dynode rises slightly above E_{DD}; the plate potential drops slightly below E_{BB} when it collects the electrons. The drop in plate potential is fed back to the cathode through coupling capacitor C. Since the plate current is several times larger than the cathode current, the signal fed back to the cathode can be made of sufficient magnitude to overcome the cathode rise resulting from the flow of cathode current and to drive the cathode negative. This lowering of the cathode potential corresponds to an increase in grid potential. Consequently, more electrons are released from the cathode. Thus, even if the initiating pulse on the control grid should end during the cycle, feedback will keep repeating until the conduction of the tube has built up to a saturation level. Saturation is reached when the plate and dynode potentials have become substantially equal so that the plate can no longer collect all of the secondary

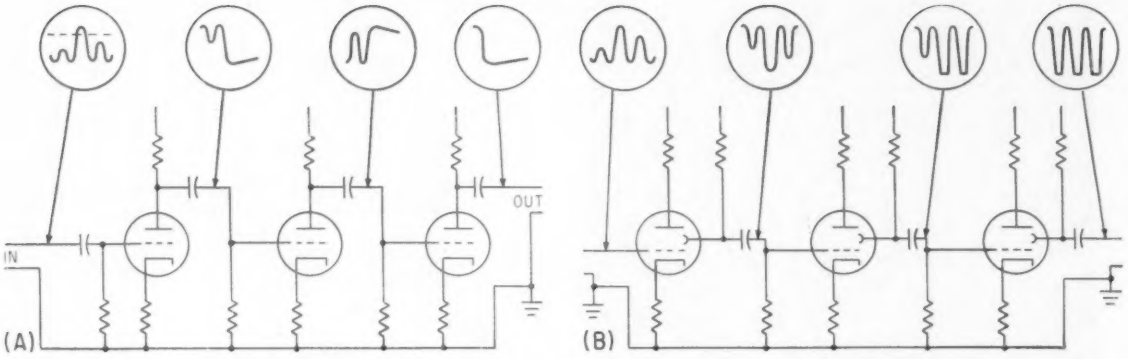

FIG. 3—Amplification by conventional cascade (A) and by cascaded secondary-emission pentodes (B)

electrons from the dynode.

With the tube in the heavily conducting state, the cathode begins to rise from its highly negative potential as the charge on the feedback capacitor is equalized through the cathode resistor to ground. This relatively slow rise of cathode potential has little effect on either the dynode or plate potentials so long as the supply of primary electrons from the cathode is large enough to maintain a rate of secondary emission at the dynode equal to or greater than the rate at which electrons can be collected by the plate. However, once the cathode potential rises to where liberation of primary electrons becomes small enough to result in a rate of production of secondary electrons at the dynode less than the rate at which the plate can collect electrons, the plate current will decrease slightly. The rise in plate potential is fed back to the cathode to further decrease the supply of primary and consequently secondary electrons. The tube is driven rapidly into cutoff and remains cutoff until another positive grid pulse is applied.

The circuit shown in Fig. 1A produces a positive output pulse across the dynode load each time it is triggered by a positive grid pulse. In Fig. 1B, a similar arrangement is shown for the production of a negative output pulse across the plate load. Feedback is from dynode to control grid, rather than from plate to cathode. The diode in the grid circuit in Fig. 1B insures that the feedback pulse is not impressed on any other circuit that might be connected to the input terminals and also to make the feedback nearly independent of the impedance of the input generator. This second consideration is important when the positive trigger input is derived from a relatively low-impedance source that might make the development of the feedback signal difficult. An alternate form of this circuit, which can be used when a negative trigger pulse is available, is shown in Fig. 1C. The diode is not necessary in the input circuit since feedback is from dynode to control grid while the negative trigger pulse is impressed on the cathode.

In the trigger circuits of Fig 1A through 1C, it is necessary that the grid be biased beyond cutoff because whenever cathode current flows in any of these circuits, regeneration takes place. With a grid that is not biased to cutoff, any of these circuits will free-run. That is, another cycle of regeneration will begin each time the circuit recovers from the previous cycle. Then the circuit is no longer a trigger circuit, but rather a pulse train generator.

The EFP-60 transfer characteristics shown in Fig. 2A are typical of secondary-emission pentode transfer characteristics. They show there is a disadvantage to the operation associated with the circuits of Figs. 1A through 1C. Each regeneration cycle must begin from cutoff where the tube transconductance, and consequently the circuit gain, is relatively low. The circuit shown in Fig. 2B obviates operating the tube at or beyond cutoff in the quiescent state, and makes it possible to obtain an output pulse with a somewhat shorter overall rise time. In the circuit of Fig. 2B, regeneration is prevented by the biased diode in the feedback circuit. No feedback can occur until a negative-going pulse, which has an amplitude greater than the bias on the diode, appears at the plate. Adjustment of the diode bias allows the sensitivity of this circuit to be varied; the circuit may therefore be used as a pulse-height discriminator as well as a trigger circuit.

A variation of the trigger circuits can be obtained by replacing the feedback capacitor with an open-circuited section of transmission line. Figure 2C shows such an adaptation applied to the regenerative circuit in Fig. 1A. Upon application of a positive grid pulse to this circuit, the progress of the tube into the metastable, saturation-conduction state proceeds as described. The negative-going voltage step on the plate is transmitted down the length of transmission line in the feedback path. In-phase reflection of this voltage step at the open-circuited end of the line causes the potential difference between the two conductors to double as the reflected step is transmitted back up the line. Since the plate is drawing saturation current, its potential with respect to ground cannot change when the reflected step reaches the tube end of the line. Consequently, the reflected step voltage is developed as a positive-going voltage on the cathode. The result is a sharp decrease in primary electron flow that causes a sharp decrease in secondary electron flow to the plate and the tube is driven rapidly into cut-

off. Since the duration of the high-conduction state is dependent upon the length of the section of transmission line in the feedback path, the duration of the output pulse taken across the dynode load is adjusted by varying the length of this transmission line.

The secondary-emission pentode can be used for voltage amplification without phase inversion of the signal[7, 8, 9].

This feature leads to the possibility of applications that would be difficult or impossible using more conventional tubes. One application is the trigger amplifier, shown in Fig. 3A. This amplifier might be used with one of the trigger circuits.

Suppose that it is desired to trigger a regenerative circuit similar to the one discussed in Fig. 2B, with each one of the pulses in the pulse train pictured at the input of Fig. 3A. Suppose, further, that the lowest diode bias level at which the trigger circuit can be operated with insured stability corresponds to an input pulse height indicated by the dashed line. The pulse train must be amplified if each one of the pulses is to produce triggering. However, the use of a conventional cascaded amplifier (Fig. 3A) may be precluded because the larger pulses will be amplified to the point where they cause grid current to be drawn in the latter stages of the amplifier string before the smaller pulses have amplified sufficiently to result in triggering of the regenerative circuit. The amplifier circuit shown in Fig. 3B presents a solution. The positive pulses in the train are amplified and converted to negative pulses by the first stage in the conventional manner. In subsequent stages, the negative pulses are amplified without phase inversion by taking the outputs of the second and successive stages from the dynodes rather than the plates. As the amplification proceeds stage by stage, there is no possibility of any stage being made temporarily insensitive by grid conduction. On the contrary, as amplification proceeds down the cascaded stages, the amplitudes of the larger pulses are limited to a value determined by the grid biasing on the stages. Thus the output of the amplifier string can be a train of pulses, all of which have the same amplitude. The requirement that the pulses be positive to trigger the regenerative stage is satisfied by taking the output of the final stage from the plate rather than from the dynode. Amplitude is limited without clipper stages.

Another example of how the secondary-emission pentode can be applied to advantage is shown in Fig. 4—a distributed amplifier from which balanced push-pull outputs can be obtained. With conventional pentodes, two separate amplifier strings would be required to achieve comparable results.

Up to this point, the discussion has been concerned with a representative coverage of what might be called conventional secondary-emission pentode circuit applications, although here the conventional is somewhat unconventional when compared with ordinary vacuum-tube circuits.

As a final example of the uses that can be made of secondary-emission pentode properties, consider the cathode-follower circuit shown in Fig. 5[10].

Figure 5 shows that the circuit is an ordinary cathode-follower

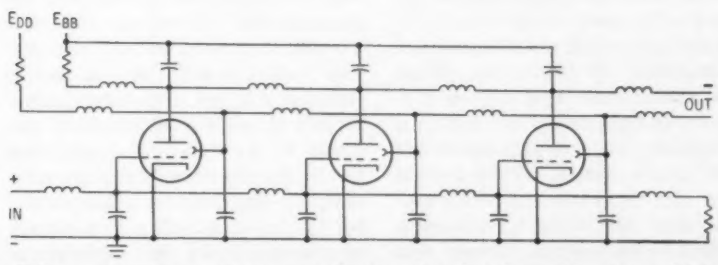

FIG. 4—Secondary-emission pentodes in a distributed amplifier from which balanced push-pull outputs can be obtained

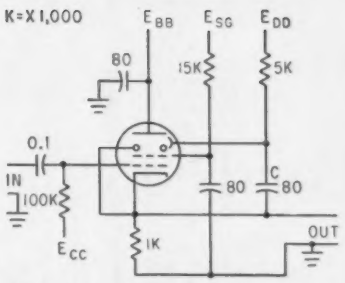

FIG. 5—This cathode follower circuit is useful for matching high-impedance sources with low-impedance loads

enhanced by the connection of the dynode back to the cathode. This circuit uses degenerative feedback, in much the same way that the trigger circuits use regenerative feedback, to achieve high-performance impedance transformation. This takes advantage of the high effective transconductance of the secondary-emission pentode in the cathode-follower circuit, even though the cathode current is only a small fraction of the plate or dynode current. This circuit can be applied when it is necessary to match a high-impedance source and a low-impedance load.[11]

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Low-Level Multiplexing For Digital Instrumentation

Coupling transformers link transistorized input switches to a-c amplifiers. Input and output circuits are zeroed during blank time between channel sampling periods to eliminate amplifier drift

Electronic multiplexer can directly acquire and multiplex outputs of low-level strain gages, thermocouples and other transducers

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A MULTIPLEXER is a commutator in which a number of voltages are sampled sequentially, producing a serial pulse-modulated output. In a typical digital instrumentation system, the multiplexer output is fed to an analog-to-digital converter for conversion to a digital number. To date, all electronic multiplexers have been of the high-level type, requiring individual d-c amplifiers for each input voltage. In a system involving many channels, the cost of the amplifiers becomes sizable.

The 48-channel multiplexer described results in a saving of approximately 50 percent over a similar system using d-c amplifiers. This cost saving, and increased reliability through decreased complexity, are the primary advantages of a low-level multiplexer in a digital system.

The multiplexer can commutate up to 48 channels, each channel being able to produce a full-scale output with as low as ±5 millivolts input at a maximum channel rate of 24 Kc. The resolution capability at the input is 10 microvolts Unit is linear to within 0.1 percent of full scale. Common mode rejection is 10^6 to 1 with a maximum common mode voltage of 180 volts.

A simplified block diagram of the multiplexer is shown in Fig. 1A. The analog portion is divided into six identical units, each with an eight-channel capability. This size was selected to provide enough time for the transformer to recover between each use.

Each unit is driven independently at one-sixth of the system word rate, and the unit rate may be subdivided independently so that in a unit either 1, 2, 4 or 8 channels are used. For example, if the system word rate is 24,000 samples a second, each unit will be operative 4,000 times a second. If only one channel is used in a unit, it will be sampled each time the unit is operated, at the 4-Kc rate. If there are two channels in a unit, they will be sampled alternately at 2 Kc each. If either 4 or 8 channels are used, each channel will be commanded at 1 Kc or 500 cps.

Since each unit can use its channels independently of the other units, both high- and low-frequency data can be handled by one multiplexer. The sampling rate is determined by the arrangement of diodes on a matrix plug-in board, and the program can be changed by inserting a different board.

The timing numbers shown in Fig. 1B (right-hand side of Fig. 1) describe the operating sequence in sampling channel 1. During the time channel 48 is being sampled in unit 1, the shunt clamps in unit 2 are closed, shorting the inputs to a-c differential amplifier No. 2. At the same time, the zero clamp at the output of this amplifier is closed, shorting this output to ground. Since the amplifier is an a-c device, shorting its input to zero voltage and grounding its out-

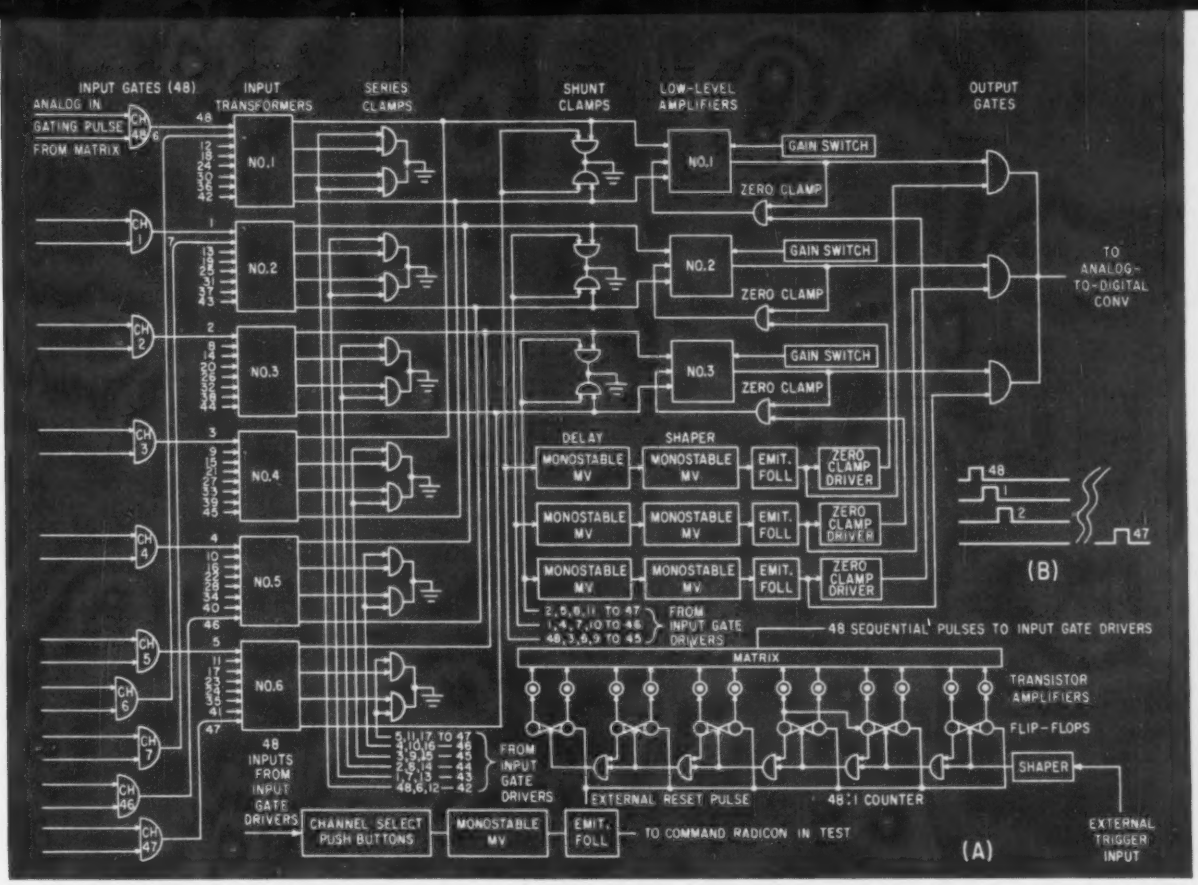


FIG. 1—Simplified block diagram of low-level multiplexer (A) shows analog portion divided into six identical units, each with an eight-channel capability; timing diagram (B) indicates operating sequence

put restore the d-c reference. Drift and stability problems that would be present with a d-c amplifier are avoided.

At the end of the channel-48 time slot (equal to 41.6 μsec at the maximum word rate of 24 Kc), the unit-2 shunt clamps and zero clamp are opened. At the same time, the channel-1 gating pulses close the input gate of channel 1 and the series clamps of unit 2. Hence, any input voltage on channel 1 is coupled through transformer No. 2 and amplified by the newly zeroed amplifier No. 2. After a delay of 20 μsec, so that switching transients are not coupled into the output circuitry, the output gate is closed, allowing the amplified signal to be fed onto the common output line to the analog-to-digital converter.

At the conclusion of the channel-1 word pulse, its input gate and the series clamps of transformer No. 2 are opened. Unit 2 is allowed to remain idle during the time the following five units are sampled. This idle time is needed to allow the transformer core material to dissipate energy stored during the sampling period. The series clamp removes all loads from the transformer to hasten its recovery.

The programming circuits consist of conventional flip-flop and diode matrices that provide the operating pulses for the system. Diode OR gates group the pulses to operate clamps and gates.

The commutating element is the transistor series switch, shown in the simplified schematic of Fig. 2. This switch AND gate is between the analog input from transducer and the input transformer (T_1).

A transistor is not a perfect switch; in the ON condition a finite series resistance exists and in the OFF condition a leakage resistance is present. In addition, a portion of the keying signal that turns the transistor ON and OFF appears at the switch terminals. For these reasons, and to reduce temperature drifts, two transistors are used back-to-back in an inverted connection (keying signal applied between base and collector).

A fused junction silicon transistor (2N495) is used in the low-level gates because: saturation resistance is relatively low (10-20 ohms); OFF resistance is high (over 10 megohms) and recovery from saturation is relatively fast (2 μsec for 500,000 ohms).

The keying signal transfer in the ON condition is relatively small and constant with temperature for certain conditions of operation (approximately 2 mv for 0.5-ma base current).

The switch can be turned OFF by removing all keying voltages from the transistor. No additional hold off bias is necessary for small signal inputs.

The transistor switch is turned ON by applying 0.5 ma between the collector and base in the conducting direction. To turn the switch OFF all voltages are removed.

A negative-going keying signal from the timing matrix is applied to the base of the driver transistor

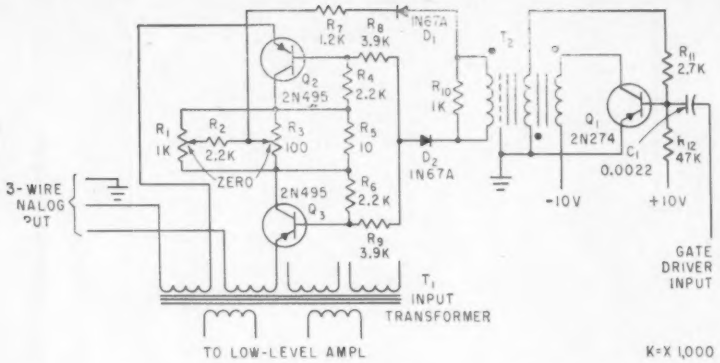


FIG. 2—Input gate circuit (simplified diagram) uses two fused junction silicon transistors back-to-back in an inverted connection. Gate driver receives keying pulse from timing matrix

Q_1 through capacitor C_1. The driver amplifier is made regenerative by a positive feedback winding on pulse transformer T_2 but is normally biased off by a positive voltage on its base from the 10-volt supply, which is across the divider formed by R_{11} and R_{12}. The input keying pulse overcomes this bias and by positive feedback, transistor Q_1 is driven to saturation.

The end of the keying pulse from the timing matrix produces a positive spike on the base of Q_1 by differentiation through capacitor C_1. This spike cuts Q_1 off. The hold-off bias takes over and the driver remains off until triggered again by a negative keying signal from the matrix.

The low-level gates are driven by a shielded third winding on pulse transformer T_2. Resistor R_{10} is a damper to reduce ringing on the secondary. Diodes D_1 and D_2 remove all keying voltages from the low-level gates in the OFF condition. Resistors R_7, R_8 and R_9 are current-limiters proportioned to give the 0.5-ma base current in the ON condition of the low-level gates. Resistors R_4 and R_6 are a low-resistance path between the base and collector of each series switch for fast recovery from saturation.

Potentiometer R_3 is the coarse zero; potentiometer R_1, with R_2, provides the fine zero. The zeroing circuit is in series with the signal line since it is connected between collectors of the series switches. The zeroing circuit is also in series with the keying circuit. Zeroing is produced by the voltage drop due to the keying signal appearing in the signal line. The polarity and magnitude of the zero signal depends on the position of the center arms of the zeroing potentiometers.

Transformer coupling is used between the input gates and the amplifiers for electrical isolation between channels and to completely isolate both sides of the input line from the system ground, thereby providing common mode rejection without double gates. The transformer also simplifies the amplifier following it since the amplifier is no longer exposed to large common mode signals.

Winding difficulties, capacitance between windings, physical size and recovery time dictated a maximum of eight primaries for each transformer (with two windings per primary). Each of the primary-winging pairs is electrostatically shielded from other primaries and from the secondary windings. The solution of the electrical and mechanical problems of the transformer is largely responsible for the development of this multiplexer.

The a-c differential amplifiers following the transformers raise the level of the signal from millivolts to a sufficient magnitude (±4 volts) for compatibility with standard analog-to-digital converters. The input is a-c coupled to the differential amplifier. Two transistors in the input are low-noise devices which are operated with low collector voltage and current. The output of the input transistors is coupled to emitter followers that match the high collector resistors of this input stage to the rest of the amplifier. The gain control is at the output of the emitter follower. The rest of the amplifier is conventional.

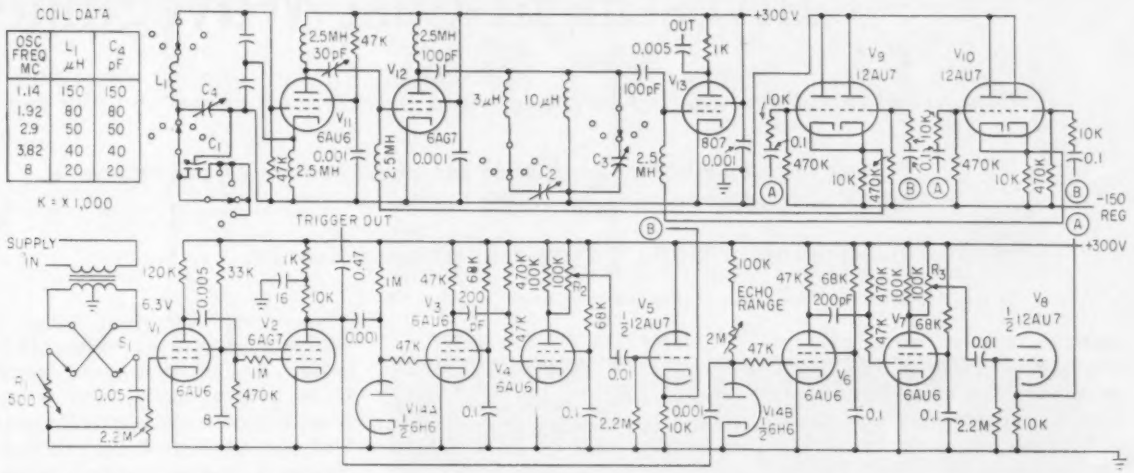
Feedback is applied around the last two stages. The single-ended output signal is coupled through an emitter follower to the zero clamp and output gate shown in Fig. 1. Just prior to the time in which the amplifier is used the zero clamp shorts the output to ground to restore d-c reference.

Pushbuttons are on the front of the multiplexer so that the coded value of any one of the 48 channels can be observed when the unit is used with a Radiation Inc. analog-to-digital converter (Radicon). Depressing a button feeds a command pulse to the converter so that the selected channel code is gated into the display circuits. The display is on the front panel and consists of Nixie tubes or neon lights, depending on the converter model.

Gain controls are provided for each of the three amplifiers. On the multiplexers four gain steps are provided: ±5, ±15, ±25 and ±50 millivolts. However, other values could be provided if desired.

The multiplexer can be used where it is desired to commutate a number of millivolt-range voltages. However, the breakeven point, from a price standpoint, is probably at about 10 channels—a system having a fewer number of channels can be handled more economically by using individual d-c amplifiers and a high-level multiplexer.

To date, 12 low-level multiplexers have been installed by Radiation Incorporated at the Thiokol Chemical Corp. facility near Brigham City, Utah. These units are used for static testing of Minuteman's solid-propellant rocket engines. Input voltages have been received from various transducers. Because of the long signal leads (up to 300 feet) between the test bay and the instrument bunker, shielding and grounding techniques were important. Peak-to-peak noise levels of less than 12 microvolts have consistently been obtained. Thus, no particularly difficult noise problems arise with the low-level multiplexer that are not present with d-c amplifier installations.



Cathode-follower mixer pulser and a c-w oscillator pulsing a buffer are used to meet equipment requirements

TRANSMITTER SIMULATOR

TESTS PULSE AND PHASE-PATH RECEIVERS

By K. PERRY, Technical Assistant, Dept. of Physics, University of Queensland, St. Lucia, Australia

SIMULATION OF FIELD CONDITIONS encountered by pulse receivers used in ionospheric soundings requires a unit capable of supplying a powerful pulse followed at a given time by a weak pulse. The echo (weak pulse) must be variable in range and capable of moving through the fixed ground pulse without any addition of the pulses. The transmitter simulator in the figure meets these requirements fully.

Since the two pulses bear a fixed phase relationship to each other this unit can also be used in the development of phase-path equipment.

Tubes V_1 and V_2 are squaring stages, squaring the 50-cps heater supply. (Hence the prf is 50 cps.) Switch S_1 is a phase reversing switch and R_1 a fine phase control. Locking the unit to the supply means test cro's and indicators can be line triggered. Locking also enables the echo to precede the ground pulse, which is useful for checking ground pulse gating circuits in receivers. Tube V_3 is a fixed delay, and V_4 a fixed ground pulse generator of 200 μsec.

An external trigger is supplied from the anode of V_3 for indicator units using an externally triggered time base. Delay stage V_5 is incorporated because these indicators normally do not have any delay facilities. Potentiometer R_2 controls the amplitude of the ground pulse which is fed to cathode-follower mixer pulsers V_9 and V_{10} by cathode follower V_8. The trigger from V_3 is fed to a variable delay stage, which simulates echo range, then to fixed echo pulse generator V_7 and, via cathode follower V_8, to the cathode-follower mixer pulsers. Echo amplitude is controlled by R_3.

Tube V_{11} is a normal vfo running at half the output frequency to reduce r-f leakage between pulses. Pulsed frequency doubler V_{12} uses a band-pass type anode tank circuit to reduce the number of inductances required. Two inductances cover all bands. Capacitors C_3 and C_4 are a combination of fixed capacitors and air trimmers. They should be kept approximately equal.

A low impedance output is provided by V_{13}. There is an obvious mismatch here between the 807 anode and receiver input. However, this is warranted in the interests of simplicity, and in practice the scheme works perfectly. The fine tuning capacitor, C_1, is the only tuning control available on the front panel. It is a butterfly type of 20 pf per side, from which all the plates on one side were removed. The remaining capacitance between the rotor and frame was found to be just right for the 16-Mc band.

The cathode-follower mixer pulsers V_9 and V_{10} are run off a negative bus, so that normally buffer stages V_{12} and V_{13} are cut off. As the mixers grids are raised by the positive pulses from V_8 and V_4, the grids of V_{12} and V_{13}, become less negative and begin to amplify.

A unit has been in operation for some 15 months and has been extremely useful. Frequencies used are those allotted to this department for ionospheric research.

Investment-Cast Waveguide

Ancient art of investment casting by the lost-wax process has been brought up to date in the manufacture of microwave waveguide components. Results of a five-year study are detailed

MANUFACTURE of waveguide systems and components usually requires accurate machining and assembly by soldering or dip-brazing.

Warpage can occur and produce components of nonuniform physical characteristics, which adversely affect their electrical performance.

In seeking improved methods for making the tortuous waveguide shapes requiring a high degree of accuracy and uniformity, the ancient art of investment casting by the lost-wax method with its modern refinements showed promise. The overall electrical performance was enhanced since abrupt discontinuities, open seams and cracks were eliminated. At the same time unit production costs were reduced.

Many advantages in using waveguide components produced by investment casting techniques became apparent, even with castings of relatively simple shapes. The ability to reproduce castings of consistent dimensional accuracy resulted in waveguide components of significant electrical superiority and reliability. Cost advantages were also evident, even when quantity requirements were extremely low. All these advantages became more apparent as more complex castings were produced and as quantity requirements were increased.

In resorting to investment casting for production of radar components, more advantages were realized than were originally anticipated. Tooling costs were found to be most attractive even when quantity requirements were limited. This means that production casting designs and techniques can be advantageously advanced to the R & D phase, thereby eliminating much of the redesign and reengineering cost and effort in conversion to a production model. Moreover the evaluations—electrical, mechanical and environmental—are those of the production models or quasiproduction model.

Waveguide shapes that defy fabrication by machine tools can be readily cast. An example of this is the tapered twist shown in Fig. 1. In producing such a shape by investment casting, the only accurate machining in tooling is confined to making the helical core of the master pattern (F). External machining only is required here. One advantage in tooling for investment cast waveguide components is that the more accurate machining is generally confined to external machining of core pattern surfaces which ultimately form the critical internal dimensions of the waveguide.

Wax-assembly techniques have also contributed in facilitating

WHAT IS INVESTMENT CASTING?

The 'lost-wax' process used by the ancient Egyptian and Chinese civilizations thousands of years ago for casting many of their intricate art and religious objects, provided the basis for modern investment casting.

A wax pattern is made by injecting molten wax under pressure into a metal die. The wax pattern is then placed in a metal flask where it is invested in a refractory slurry. This mold is then passed through a furnace where the wax is melted out and recovered and the mold baked. The cavity left by the melting out of the wax forms the mold into which molten metal is poured.

Castings produced in this way are characterized by a smooth surface finish and dimensional accuracy. In addition, the investment casting process possesses great versatility from the stand point of attainable intricacy of castings and in the variety of alloys which may be cast

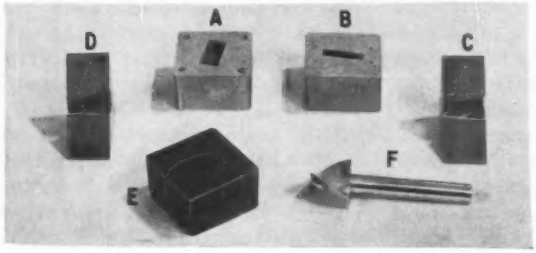


FIG. 1—Short 90-degree smooth-twist and transition from ½-size X-band to full-size X-band (A and B). Cutaways of casting (C and D) with wax pattern (E). External machining required only on helical core (F)

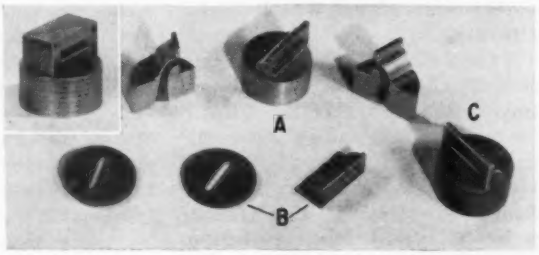


FIG. 2—Fabricated assembly (inset) uses 10 machined parts oriented by 18 dowel pins. Cast unit (A) is shown complete and in left and right cross sections. It is made with (three shown) wax patterns (B) in assembly (C)

Components

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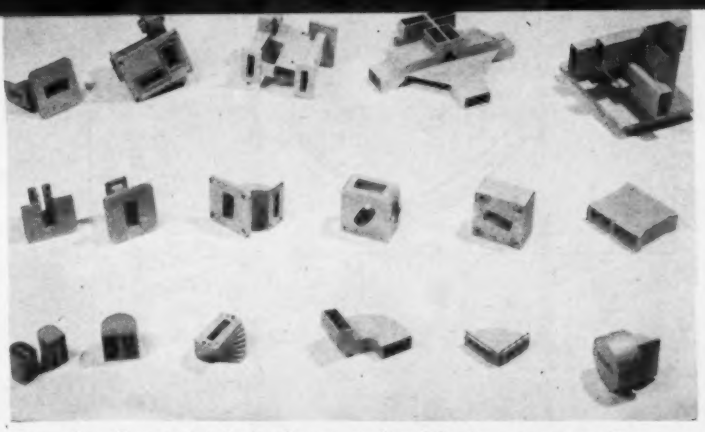


Examples of some intricate shapes produced by investment casting

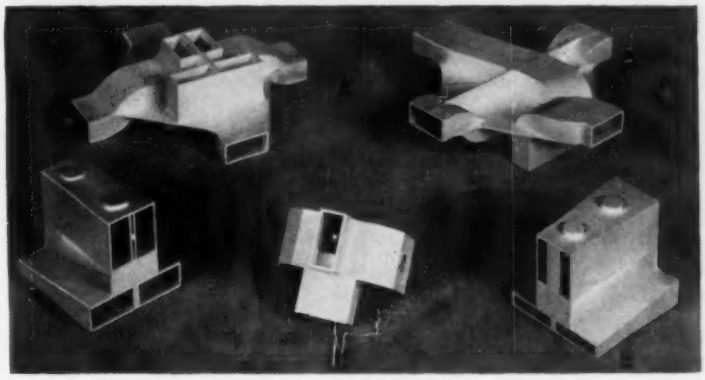


FIG. 3—Waveguide components produced by investment casting include transmitter-receiver feedlines (A), 4-channel tapered transitions (B) and mixer (C)

waveguide production by investment casting. An example of this may be seen in Fig. 2 which shows both the fabricated version (inset) and the cast version (A) of a 90-degree stepped-twist and 90-degree-E-plane bend combination. The fabricated assembly required ten accurately machined parts, carefully oriented and pinned together to achieve the internal spiral stairway configuration. In making the cast version, two types of wax patterns (B) were required for making the final wax-pattern assembly (C). Each of the wax patterns was formed with self-orienting pins and holes. In casting waveguide components, this method of wax-pattern assembly has been used to great advantage in forming threaded bosses, tuning pins, end caps, flanges and mounting decks.

The development of soluble-wax techniques during the past few years has extended the versatility and hence the application of investment casting. With regard to its use in casting waveguide components, it has in many instances simplified the tooling (molds) and has made possible casting for more complex components, with further elimination of fabrication and brazing. The solubie-wax technique uses two types of wax in forming a hollow wax pattern.

The first step is to mold a wax core that is soluble in a 5-percent aqueous acetic acid solution. This soluble wax core is then placed in a second mold where a second type of wax not affected by acetic acid is injected into the mold to surround the soluble wax core. The resulting wax pattern with the soluble core is then placed in the acetic acid solution where the core is dissolved, leaving the desired hollow wax pattern for investment. Some castings produced by compatible wax techniques are shown in Fig. 3.

In evaluating the electrical performance of cast waveguide systems and subassemblies, a comparison was made between the performance of cast units with those of identical fabricated designs. Initially, several simple waveguide configurations were cast: ½-size X-band to standard X-band step transition; 90-degree two-step twist; and E-H plane, 90-degree, ½-size X-band to full X-band transition. Electrical measurements of voltage standing wave ratio (vswr) as a function of frequency are shown in Fig. 4. These results are typical for six or more samples. Although the data obtained using both manufacturing techniques are acceptable for many applications a significant improvement in the overall performance is noticable in each case for the cast pieces. Since it would be difficult as well as impractical to produce either E or H plane 90-degree bend transitions by the machining and dip-brazing method, no comparison with this technique is made.

Similar comparisons were made on several pieces that were more difficult to cast. These included a compact X-band mixer, a compound E-H plane bend, a short multistep 90-degree twist, and a short multistep 90-degree twist-bend combination. The performance of the X-band microwave mixer can be characterized by the voltage standing wave ratio looking in the local oscillator and antenna arms, coupling from the local oscillator to mixer crystals and decoupling between the local oscillator and antenna arms. Performance curves for these characteristics are shown in Fig. 5. The data for the dip-brazed mixers represent the best performance taken from a selected group, while the curves for the cast mixers were taken from mixers selected at random. Again, in each case the results are typical for six or more of the sample units.

Performance curves on the other three components are shown in Fig. 6. Although these structures were

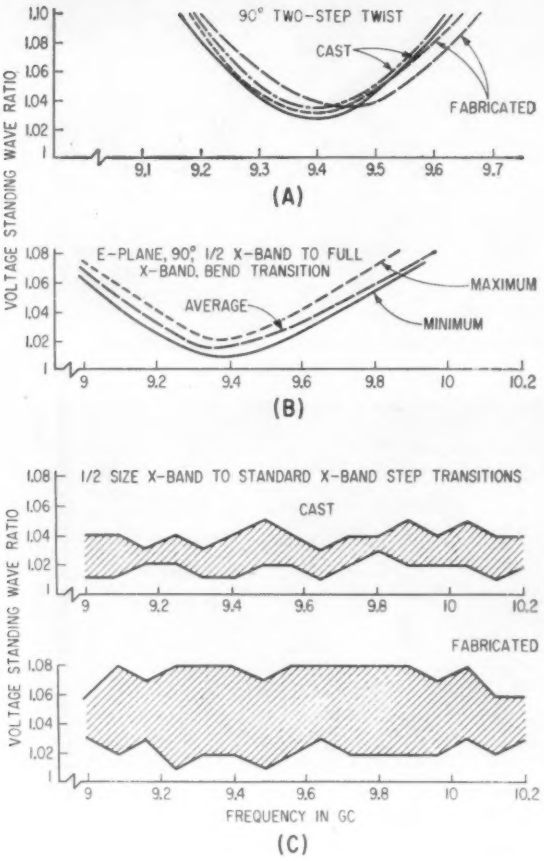


FIG. 4—VSWR as a function of frequency for 90-degree two-step twist (A); E-plane 90-degree ½ X-band to full X-band bend transition (B); and ½ size X-band to standard X-band step transitions (C)

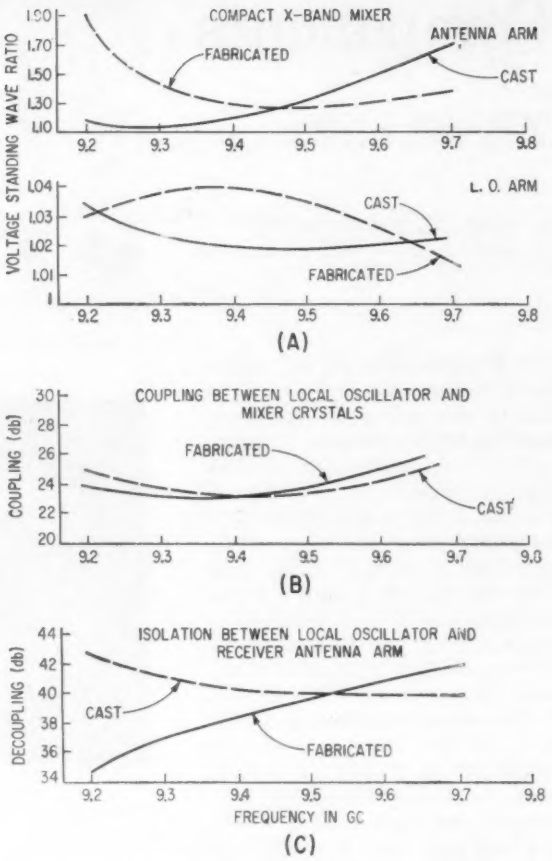
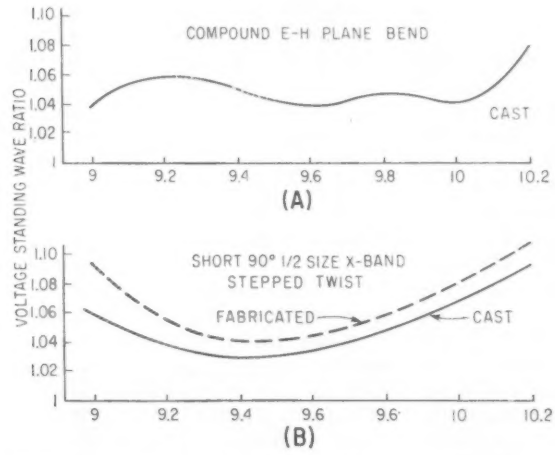


FIG. 5—VSWR as a function of frequency for compact X-band mixer (A). Coupling between local oscillator and mixer crystals (B) and isolation between local oscillator and receiver antenna arm (C)



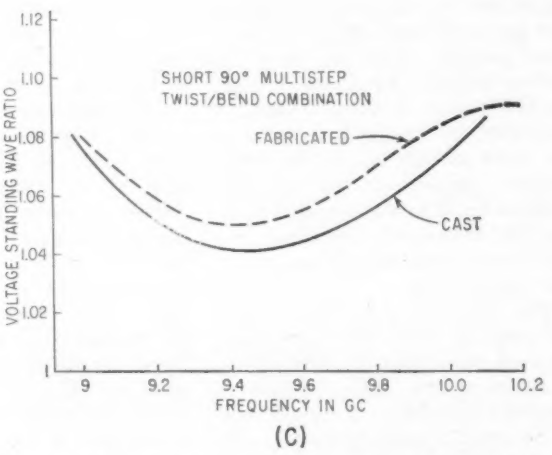
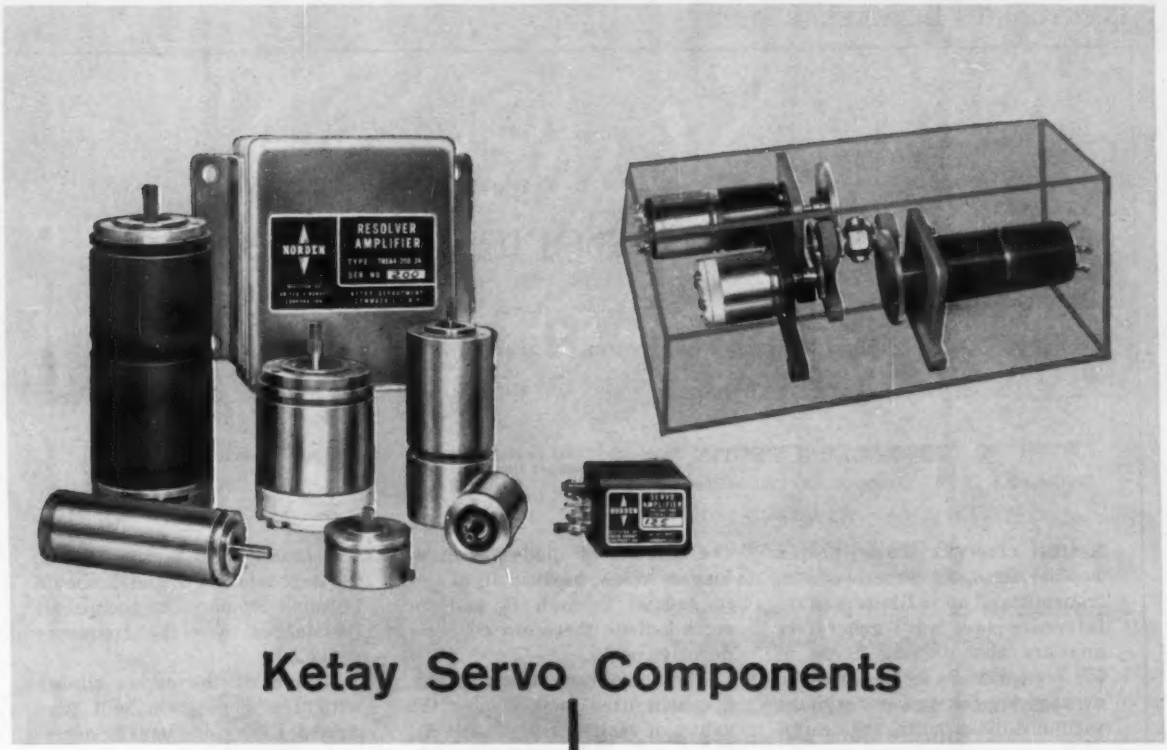


FIG. 6—VSWR as a function of frequency for a compound E-H plane bend (A), a short 90-degree ½-size X-band stepped twist (B) and a short 90-degree multistep twist and bend combination (C)

more complex, they exhibit the same general behavior as those shown in Fig. 4.

At the present time, this method of investment casting waveguide components is limited to the X, C and Ku microwave bands.

The authors thank S. Lipson of the Pitman-Dunn Laboratories, Frankford Arsenal, for his many contributions in the investment casting procedures.



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Designing Series Clippers

Nomograph gives component values for series clipper, especially useful when clipper is used with transistor circuits

By ROGER R. BETTIN, Assistant Chief Engineer, Communications Lab., Stromberg Carlson Div., General Dynamics Corp., Rochester, N. Y.

SERIES CLIPPERS have proven popular for audio circuits of a-m transmitters, noise limiters in receivers, square wave generators and are also gaining favor in ssb transmitters to increase the average-to-peak power ratio. In vacuum-tube circuits, the design of the series clipper is relatively simple since impedances and d-c voltage levels are usually sufficiently high and satisfactory operation is obtained with R_1 and R_2 of the same value. (See Fig. 1). However, transistor circuits with their lower impedances and supply voltages make a more exact solution necessary. Correct circuit values are now more difficult to find by the trial and error method and specific design information is needed.

As shown in Fig. 1, the two diodes are in series with the signal and their forward resistance is small when no clipping occurs. As the positive value of E_{in} becomes larger than the d-c voltage on the diode plates, the resistance of diode 1 becomes large, prohibiting the flow of the signal and causing clipping of positive peaks.

As E_{in} swings to its negative cycle, the voltage on the diode plates is reduced. When the plate voltage is greatly reduced, the cathode of diode 2 can no longer follow because it is tied to ground through R_3 and the second diode therefore clips the negative peaks.

The nomogram shown in Fig. 2 can be used to determine the values of resistors R, R_1, and R_2; R_3 is assumed to be known since it is the a-c impedance into which the clipper circuit is working. Supply voltage E_{d-c} is also known. For this nomogram to be valid, three assumptions are necessary. First, the resistance of the clipping control R_A, should be small in relation to R since, if it is not, adjusting the level of clipping will also affect the symmetry of clipping. Second, the diode forward resistance is considered small in comparison to the circuit resistances. Third, the impedance of C_1 and C_2 should be small compared to the circuit resistances over the frequency range.

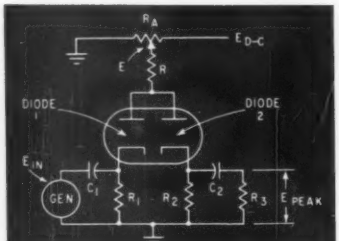

FIG. 1—Potentiometer R_A in series clipper varies clipped amplitude between zero and E_{peak}

Design of the series clipper with the nomogram will give three desirable and usually necessary features: positive and negative peaks of the audio wave are clipped at the same voltage magnitude (symmetrical clipping); when voltage E is equal to the supply voltage E_{d-c}, the clipped voltage level across R_3 will be a maximum and predictable from the value of the circuit constants; and the clipping level decreases as E is decreased—when E becomes zero, infinite clipping will occur.

A design problem will indicate the sequence of operations performed on the nomogram to find the values of R, R_1 and R_2. Assume the value of R_3 is 10,000 ohms, the power supply voltage E_{d-c} is +26 v d-c and the output voltage E_{peak} (clipped voltage) is ± 2 v. Plot the values of R_3 and E_{d-c}/E_{peak} (or P) on the left R_3 line (point A) and the P line (point B), respectively, and draw a line connecting points A and B. The value of 31,000 ohms for R can be read at point C on the nomograph where, you can see,

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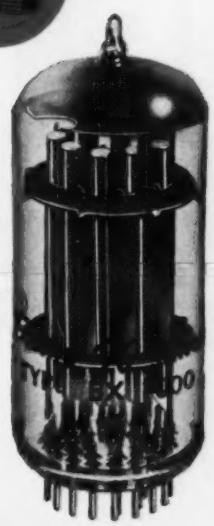

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the drawn line intersects line R.

Plot the value of R_3 on the right R_3 line (point D) and draw a line connecting points D and C. The value of 26,000 ohms for R_2 can be read at point E where the drawn line intersects the line designated R_2.

To find R_1, it is necessary to find the parallel resistance of R_2 which is labeled R_0 and can be thought of as the a-c impedance that the clipper sees. Thus, R_0 equals $R_2R_3/(R_2 + R_3)$ or 7,222 ohms and the value of R_0/R is 0.23. Plot the latter value on line R_0/R (point F) and draw a line connecting points E and F extending it to intersect line R_1 (point G). The value for R_1 can be read as 20,000 ohms.

The nomogram was constructed from the following design formulas and to some these circuit design procedures may prove to be more useful than the nomogram itself

$$R = R_3\,(P - 2\sqrt{P - 1})/2$$

where $P = E_{d-c}/E_{peak}$,

$$R_2 = \sqrt{2R\,R_3}, \text{ and}$$

$$R_1 = R\,R_2/(R + R_0$$

where $R_0 = R_2\,R_3/(R_2 + R_3)$

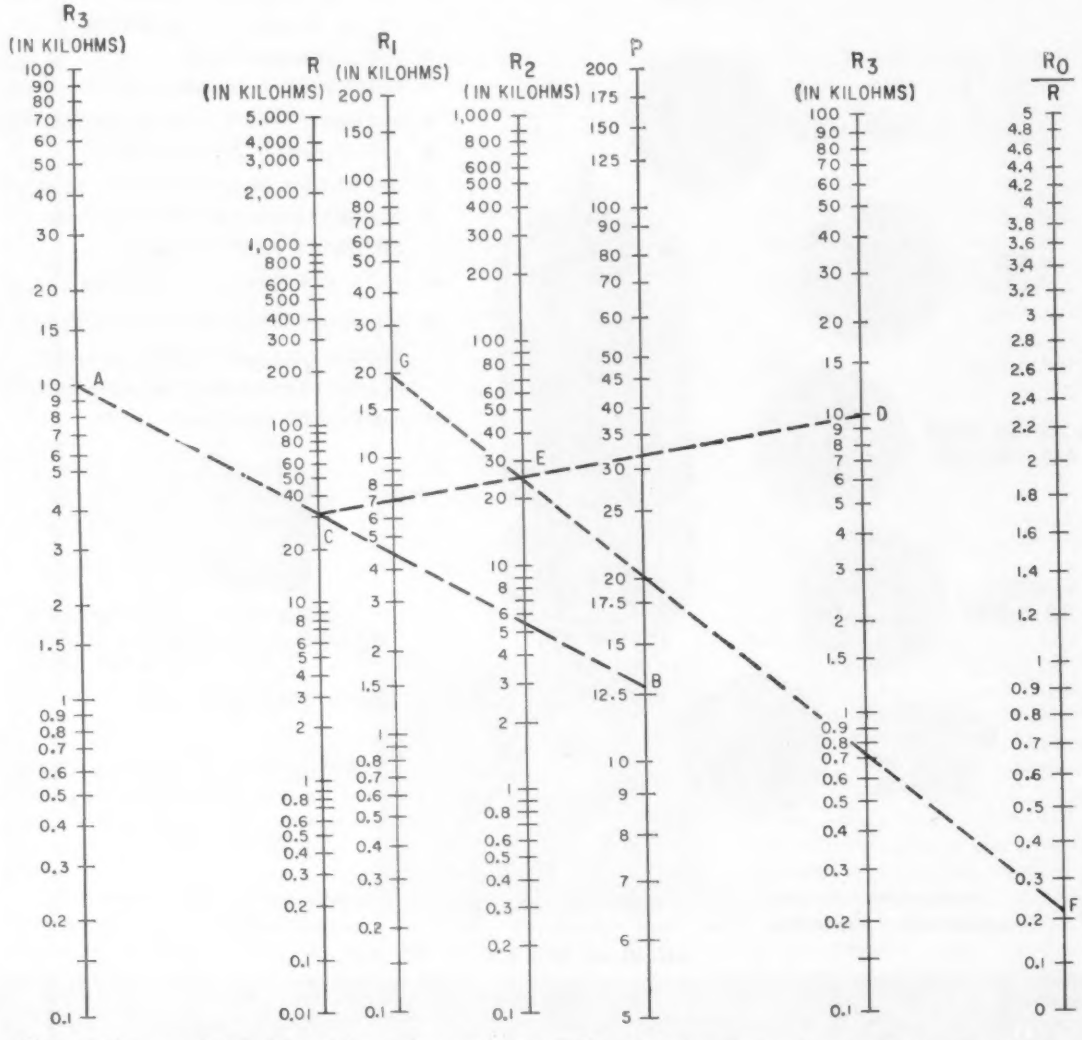
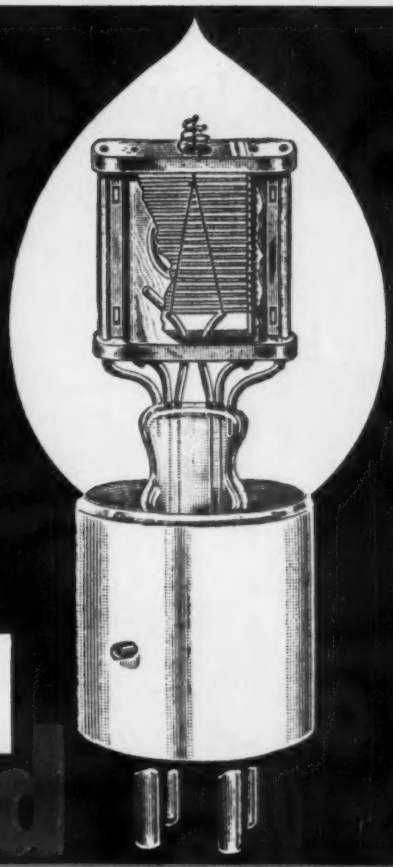


FIG. 2—Nomograph for determining values of R, R_1 and R_2 of series clipper shown in Fig. 1. Dashed lines illustrate problem in text



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D-C Motor Controls Improve System Accuracy

By F. W. KEAR, R&D Lab Supervisor, Lytle Corp., Albuquerque, N. M.

MISSILE guidance systems, instrumentation of rocket sleds and navigation devices are examples of equipment that rely on direct-current motors to detect physical or electrical quantities. Because system accuracy depends on the d-c motors, circuits have been developed for close control of their shaft rotational velocity and of overshoot and response time when velocity is changed. Such circuits have improved accuracy of existing systems and in many cases made possible the successful design of new systems.

D-c motors may be used in vertical or rate gyros. Operation of some accelerometers is based on d-c motor torsion and opposing acceleration forces. High-accuracy fluid distortion accelerometers rely on interaction of acceleration forces and centrifugal force resulting from rotation of a d-c motor.

In one application, a motor switch is operated by the opposing forces of motor torsion and acceleration. Motor torsion opens the switch in Fig. 1, reducing rotational velocity and therefore torsion of the d-c motor. When torsion is reduced because the switch has opened the motor circuit, acceleration forces exceeding the torsion close the switch again. Rotational velocity of the motor shaft is therefore directly related to acceleration forces acting on the switch.

A simple on-off arrangement like that in Fig. 1 permits considerable overshoot when rotational velocity is changed. Therefore the usefulness of this circuit is quite limited in applications that require highly accurate control of the d-c motor.

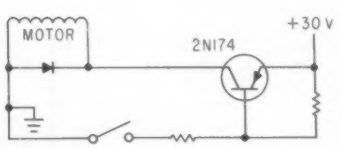

FIG. 1—Simple on-off switching of d-c motor by opposing torsion and acceleration forces permits overshoot

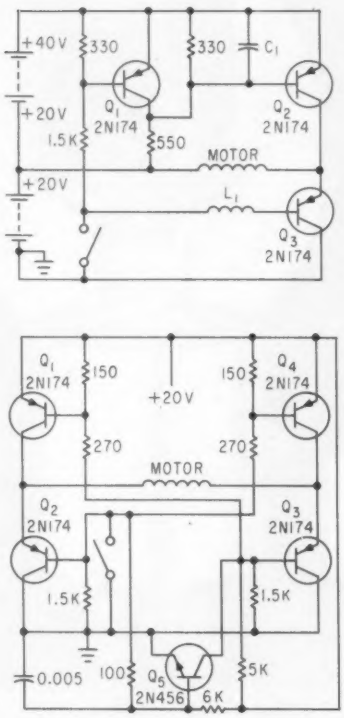

FIG. 2—Bidirectional circuit at top has two current sources to increase or decrease motor speed, while bottom circuit requires only one source

Significant improvement in controlling motor response time, and therefore system accuracy, is made possible with the circuit at top of Fig. 2. It functions as a bidirectional current switch that selects one of two oppositely polarized current sources for the motor. The position of the motor switch determines the current source used. This circuit, instead of simply applying or removing motor current, can increase or decrease motor shaft rotational velocity.

Polarity of current through the motor winding can be reversed by transistor Q_1. This transistor switch either causes Q_2 to saturate while keeping Q_3 cutoff or causes Q_3 to saturate while keeping Q_2 cutoff. Capacitor C_1 and inductor L_1 provide sufficient time delay so that when power is initially applied to the circuit Q_2 and Q_3 are not saturated simultaneously.

Switching from a single current source can be accomplished with the circuit at the bottom of Fig. 2. Transistor Q_5 is used to determine direction of current flow through the motor winding, which in turn depends on the position of the motor control switch. Either Q_1 and Q_3 are saturated simultaneously or Q_2 and Q_4 are saturated simultaneously. When one of these pairs of transistors is saturated, the other pair is cutoff.

Time required for the circuit to apply current to the motor is determined by the R-C time constants of the transistor base circuits. This response time is also related to the characteristics of the particular type transistors used.

The incorporation of bidirectional switching circuits in systems has resulted in vast improvements in their performance. In many cases, it has been possible to use d-c motors in systems only because bidirectional switching circuits enabled the motors to be controlled.

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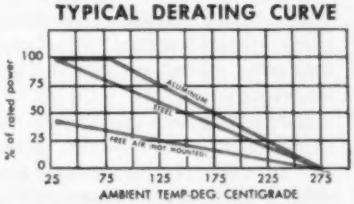

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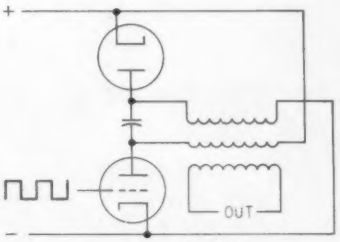
conducts with one winding of a dual-branch inductor forming the plate load. The second branch of the inductor is connected between the plate of a vacuum-tube recovery diode and the negative terminal of the d-c plate supply.

Each of the two windings carries only d-c. The windings are connected in parallel with respect to a-c, with a large value capacitor connecting the plate ends of the windings to keep them at the same a-c potential. Load for the induction-heating power source is inductively coupled to the dual-branch inductor.



Each winding of dual-branch inductor passes current in only one direction

Because current flows in only one direction in each branch of the circuit, consumption of d-c power is said to be considerably reduced from that required for a conventional tuned circuit to furnish equal power to a load. In addition, duty cycle and frequency can be easily adjusted for particular applications by varying the input drive pulses.

Oscilloscope Measures Nuclear Half-Lives

OSCILLOSCOPES can be used to measure nuclear half-lives. Information about these electromagnetic transitions between nuclear states is necessary for a systematic understanding of nuclei. However, previously used methods for making these measurements have been limited to a small part of the half-life region.

Electromagnetic transitions with half-lives from 10^{-1} to 10^{-9} seconds can be measured by delayed coincidence techniques. However, one reason that so few systematic investigations have been reported

may be that the range of the equipment used was limited.

Oscilloscopes can cover the entire time range of interest. Although use of an oscilloscope for this purpose was reported in 1947, their application for measurement of half-lives since then has been limited. However, the accuracy and flexibility of modern oscilloscopes would make their use seem highly desirable. This assumption led to a systematic investigation by a group at the Nobel Institute of Physics in Stockholm, Sweden. The Air Force Office of Scientific Research sponsored the project.

Results of the study reported by I. Bergstrom and his associates have shown that fast oscilloscopes now commercially available are simple-to-use, highly practical tools for measuring nuclear half-lives.

Seven half-lives associated with metastable states in isotopes of lead, tantalum and rubidium were measured to demonstrate the problems associated with measuring in different half-life regions. Half-lives ranged from 4 millisec for Pb^{205} to 11 nanosec for Ta^{181}. A ratio of almost 10^6:1 was covered in measuring these half-lives. Under favorable circumstances, it is believed that this ratio can be extended to 10^8:1.

The half-lives measured were reasonably well known but were chosen simply to evaluate the usefulness of an oscilloscope for making the measurements. However, the research group found a new case of nuclear isomerism in Pb^{205}. Half-life of the transition was found to be 55 nanoseconds.

An additional advantage to the wide time range available and the other desirable characteristics of an oscilloscope for these type measurements is its availability in even small nuclear laboratories. A further advantage is that it can be be incorporated in a setup for measuring half-lives yet at other times it can be used for a wide variety of other tests and measurements. When using the oscilloscope in a setup for measurements above about 1 μsec, it can function as a multichannel analyzer by continually photographing events on the screen. Thus a permanent record is provided of results.

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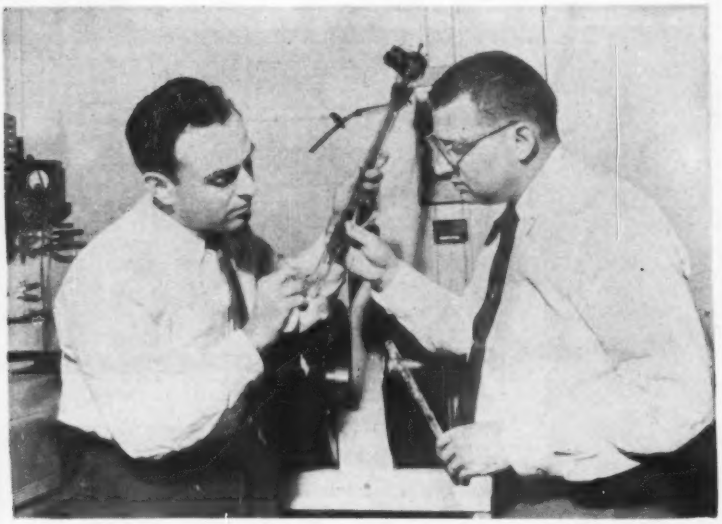
Thermoelectric Alloy Has High Efficiency



Raymond Wolfe and Jack H. Wernick, of Bell Telephone Laboratories, check the mounting on a sample of silver antimony telluride before measuring its Hall coefficient. The sample was cut from a zone-refined crystal of the new thermoelectric material similar to the one in Wernick's hand. Silver antimony telluride appears to be one of the most efficient materials yet invented for themoelectric applications

STUDIES UNDER WAY at Bell Laboratories on what appears to be one of the most efficient thermoelectric materials yet developed were recently discussed at the International Conference on Semiconductors at Prague, Czechoslovakia. The compound, first discovered by J. H. Wernick of Bell, is composed of silver, antimony, and tellurium. Its chemical designation is silver antimony telluride ($AgSbTe_2$).

Thermoelectric devices presently being considered by industry are based on a principle discovered over a century ago. This discovery showed that when two dissimilar metals were joined together in a circuit, a current could be produced by heating one junction, while the opposite end was maintained at a relatively lower temperature. The reverse of the effect was also found; if a current was passed through the pair, one junction became hotter and the other cooler, depending on the direction of current flow. The effects in metals are quite small, but with the accelerated study of semiconductors following the invention of the transistor, much more efficient materials were found.

Extensive development work is now being carried out on practical devices such as heat-to-power converters and localized coolers, especially for miniature electronic devices. Although inadequate for many proposed applications, the materials most widely used in present-day thermoelectric devices are lead telluride and bismuth telluride. The search for improved materials at Bell Laboratories centered on ternary intermetallic semiconductor compounds, many of which have a cubic crystal structure similar to sodium chloride. The desired crystal formation is somewhat disordered and contains heavy atoms such as tellurium. Many compounds, and alloys of compounds, some with as many as seven elements, have been produced and studied. The best of these discovered to date has been silver antimony telluride. This material is now being widely studied in laboratories.

Synthesis of these alloys involves the direct fusion of stoichiometric quantities of the desired elements. Zone refining is then used.

The material possesses a very low thermal conductivity, necessary in order to maintain a temperature differential between two ends of a device. Its thermoelectric figure of merit, Z, has recently been measured by scientists at Radio Corporation of America, and is reported to be about 1.75×10^{-3}/°C over a range of 200 to 500C, which is the best yet observed for p-type thermoelements in this range.

In studies reported at Bell, silver antimony telluride was described as having a disordered cubic structure, exhibiting a thermal conductivity as low as 0.0064 watts/cm C at room temperature, only one one-hundredth that of germanium. While the material is always thermoelectrically p-type, its Hall effect is p-1 type in some specimens, and n-type in others.

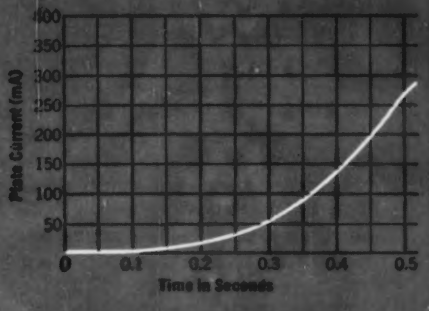
Dr. R. Wolfe, Dr. J. H. Wernick, and S. E. Haszko, all of Bell Laboratories, ascribe this anomolous behavior to the presence of a small amount of a second phase consisting of silver telluride, which is swept to one end by zone refining. This n-type compound appears to dominate the room temperature Hall coefficient at concentrations as low as 10 to 20%, while the p-type silver antimony telluride dominates the thermoelectric properties. Further studies of these anomolies are in progress and are expected to advance semiconductor knowledge.

Among the objectives of these investigations is the realization of the optimum properties of this potentially useful material. In particular, the metallurgical problems of producing single phase materials and controlling carrier concentration are of primary importance.

Polyolefin Tubing Forms Tight Bond

AVAILABILITY of a new polyolefin tubing and sleeving material which heat shrinks in diameter to form a

The tube that transistors made necessary!



RF Power Amplifier – Class C Telegraphy

	ICAS	ICAS	
Frequency (mobile)	25-50	148-174	mc.
DC plate voltage	600	600	volts
DC screen grid voltage	200	200	volts
DC plate current	2x40	2x40	mA
DC screen grid current	5.5	4.5	mA
DC control grid current	2x1.2	2x1.3	mA
Plate input	2x24	2x24	watts
Plate dissipation	2x6.5	2x7.2	watts
Power output	35	33.6	watts

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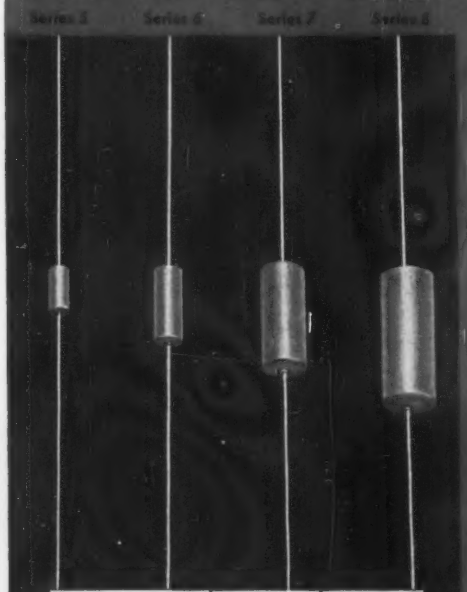

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Fansteel S-T-A Solid Tantalum Capacitors are available in capacity ranges of 0.033 to 330 mfd, from 6 to 35 wvdc. Construction and characteristics are perfectly suited for transistor circuitry—military or commercial.

For complete technical data, including specifications, typical curves and ordering references, write for Bulletin 6.112-5. Fansteel Metallurgical Corporation, North Chicago, Ill., U.S.A.

FANSTEEL — where reliability dictates standards

C607A

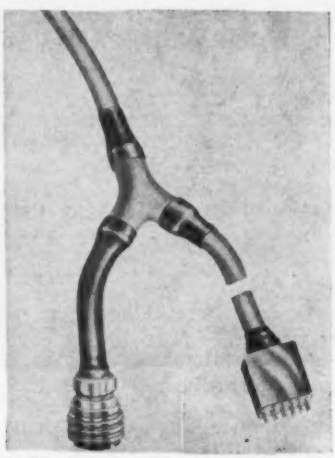
tight bond, even over irregular shapes is announced by Sequoia Wire & Cable Company—a subsidiary of Anaconda Wire & Cable.

Flame retardant and thermally stable, the new flexible tubing—designated as Hyshrink—can be slipped easily in its expanded form over terminals, connectors, wire and cable, conduit, and hose. Upon application of heat (275 F.), the tubing shrinks in diameter to form a strong mechanical bond. This heating will not affect the flexibility of the irradiated tubing. Longitudinal shrinkage is less than 10 per cent.

The material has high dielectric and mechanical strength and tested resistance to most chemicals, including JP4 and 100/300 aviation fuels and hydraulic fluids such as Skydrol. The new tubing also resists fungus growth, gives off no toxic fumes when heated, shows a weight increase of 0.01 per cent or less after immersion in water, and remains flexible and strong from temperatures of minus 67 F. to plus 275 F. Within this range, the applied tubing will not melt, harden, flow, run, crack, or blister.

Entirely free of radioactivity, the versatile tubing and sleeving material—because it has been irradiated—demonstrates exceptional resistance to radiation.

Upon application of heat, it takes but a few seconds to shrink the tubing to a pre-determined size. The use of hot airguns, ovens, radiant heat, and hot liquids are recommended for this purpose.



Cable harness shows possible application of polyolefin tubing

The new tubing and sleeving material can be used for insulating splices, connectors, pigtails, etc., and for identification purposes, because of its temperature characteristics, the material has significant application in nuclear ships and installations, space vehicles, and in other commercial and military electronic applications.

Scandium Oxide Now A Production Material

THE PRICE of scandium oxide is cut by almost 50 per cent—but in ultrapure form the cost is still $2,850 a pound. The old price was $5,500.

Vitro Chemical Co., domestic producer of the element, explains the big price cut this way: scandium was previously obtained experimentally in gram quantities. It is now a production item, being turned out by improved process techniques and expanded production facilities.

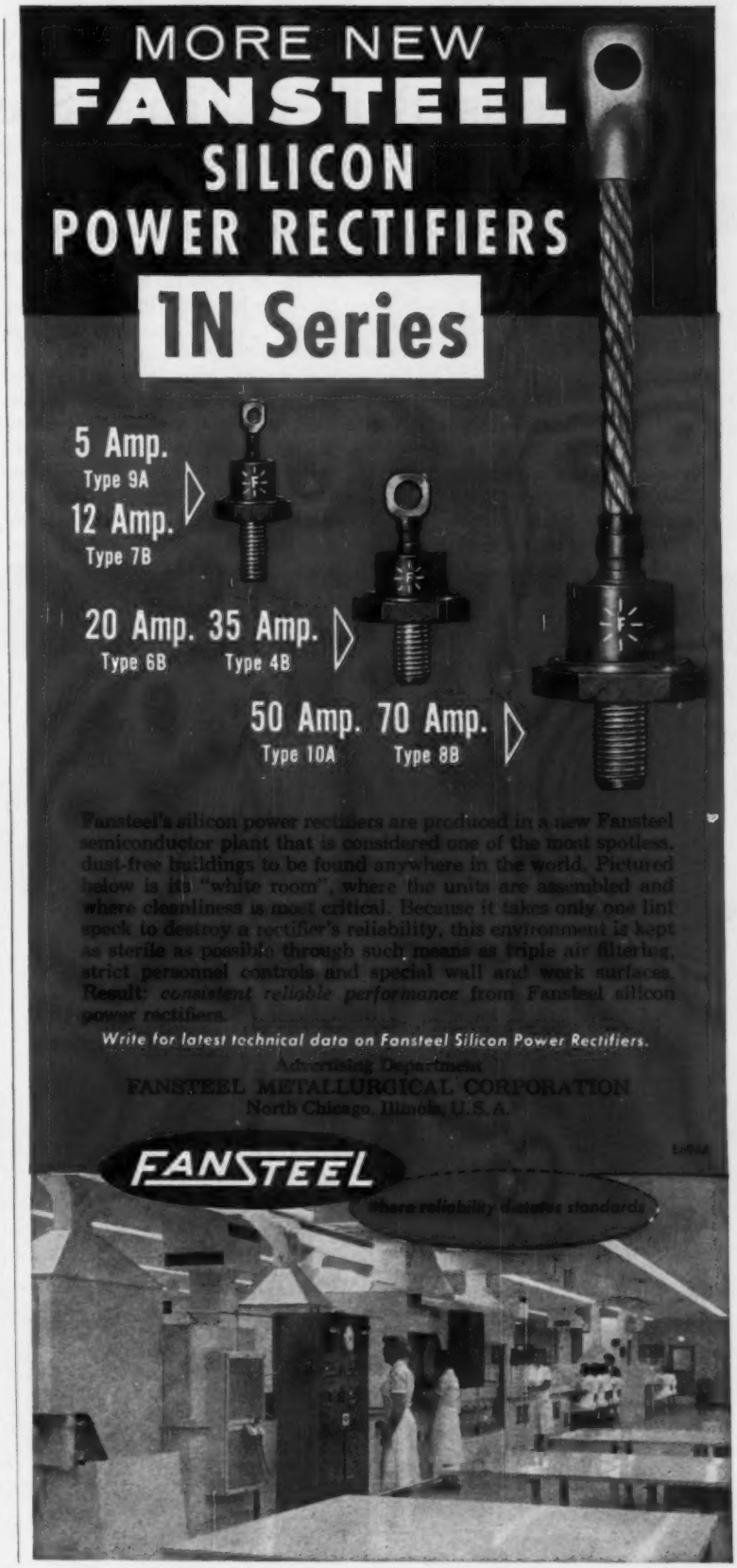
Not much is known about scandium oxide. Derived from certain nuclear ores, it has been the subject of an Air Force research program and has been used experimentally in such fields as electronics, metallurgy and ceramics. But it was previously too scarce to support wide-spread studies.

Scandium is closely related to highly-useful elements in the rare earths group which are finding their way increasingly into missiles and nuclear applications. This is one reason a lot of companies are eager to take a closer look at it.

The $2,850 price tag applies to 99.9 per cent pure scandium oxide. A purity of 99.0 per cent now costs $2,750 a pound. Old price: $4,995.

Soviet Tape Material

VIENNA, AUSTRIA—Trial production of recording tape made by galvanic metallization has been started in the U.S.S.R., McGraw-Hill World News reports. A nickel-chromium layer of four to seven microns optimum thickness exhibits a coercive force of 200-300 Oe and 5—5 k G of remanence. The properties of this new tape are claimed superior to those of tape produced from magnetic powders, the Czech Technical Digest claims.


MORE NEW
FANSTEEL
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POWER RECTIFIERS
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20 Amp.
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Fansteel's silicon power rectifiers are produced in a new Fansteel semiconductor plant that is considered one of the most spotless, dust-free buildings to be found anywhere in the world. Pictured below is its "white room", where the units are assembled and where cleanliness is most critical. Because it takes only one lint speck to destroy a rectifier's reliability, this environment is kept as sterile as possible through such means as triple air filtering, strict personnel controls and special wall and work surfaces. Result: consistent reliable performance from Fansteel silicon power rectifiers.
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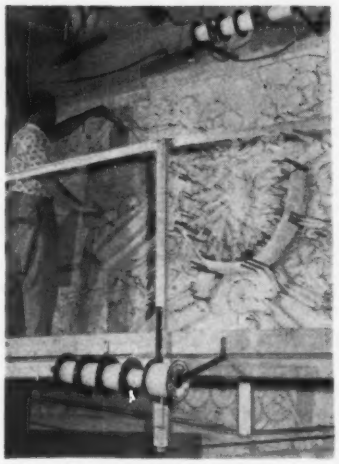
CIRCLE 83 ON READER SERVICE CARD

Scaffolds, Built-in Tables Speed Harnessing

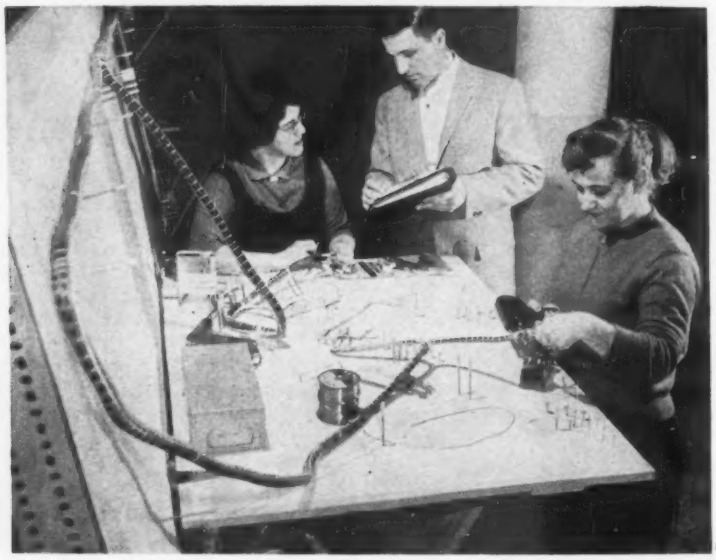
WIRING HARNESSES for large electronic systems may weigh several hundred pounds and require harness boards more than 100 square feet in area. Efficient production of such huge harnesses usually requires setups which enable any section of the board to be reached easily. If the harness can be completely finished on the same board, costs are cut further by elimination of double handling, possible damage to the harness and extra blueprints, as well as better utilization of floor space.

This approach is generally followed by the harnessing group at Raytheon Company's North Dighton, Mass., plant, which annually turns out 18,000 to 25,000 harnesses. One of the largest harnesses made here, for a nuclear submarine's sonar system, is shown on the cover. It takes about 300 hours to prepare the board and build the harness. The board measures 12 by 16 feet and contains some 1,200 guide nails. The harness weighs more than 320 pounds.

To avoid ladder climbing, all work is done from a scaffold which can be raised by power winch to about eight feet above the floor. The scaffold is locked in position, in increments of one-half inch, by steel pins placed in vertical steel posts. Fluorescent drafting lamps can be mounted on the guard rail behind the harnessers to improve illumination at the working level.



Second wire supply is mounted on scaffold



Section of harness board for radar cable swings out to provide horizontal working surface for terminal and connector soldering

Section of board shown on cover. Harnesser is coding wire ends

Women solderers also work on scaffold

The scaffold is reached by an adjacent flight of stairs.

During board preparation, small-scale drawings are used to guide the positioning of full-scale diagrams on the board. Wire end positions on the diagram are fanned out to make their identification easier and to provide more working room for inspection, wire end preparation and terminal soldering.

Precut and stripped wires are not used since the wire runs of about 400 inches are too long for preparation machines. Moreover, color-coding is not required on this harness, so all-white wire can be used directly from spools at a saving. Wire ends are identified with markers made of fungicide-impregnated cloth. The markers can be hung from a ring on the guard rail for convenience.

Wire is supplied from storage spindles holding four 2,000-foot spools of 22-gauge wire. Wire for the upper sections of the board is drawn from a spindle mounted on top of the board. Wire for the lower section is taken from a spindle mounted on the scaffold.

The harnesser's work is checked by a second man, who compares the lay-in pattern against a sequentially-numbered wiring legend. The harness is also inspected with a

CIRCLE 85 ON READER SERVICE CARD→

CANNON PLUGS

The assembling of highly-flexible electronic systems and subsystems into a modular package . . . for fast inspection, testing, service, and replacement of components . . . calls for standardized-type plugs throughout the system. Reliability and optimum flexibility in shell designs and types of layouts are the design criteria for the more than 18 different basic Cannon Modular and Rack/Panel Plug Series. This Series is available in standard, miniature, or subminiature sizes . . . for standard or printed circuitry. Up to 180 contacts and a varied combination of contacts for control, audio, thermocouple, co-ax, twin-ax, and pneumatic connections. Single or double-gang. With or without shells. The Rack/Panel Series ranges from the tiny "D" subminiature to the heavy-duty DPD Rack/Panel Plug. For further information on Cannon Modular and Rack/Panel Plugs write for Cannon DP Catalog, Cannon Electric Co., 3208 Humboldt St., Los Angeles 31. Please refer to **Dept. 422**, Factories in Los Angeles, Santa Ana, Salem, Toronto, London, Paris, Melbourne, Tokyo. Distributors and Representatives in the principal cities of the world.

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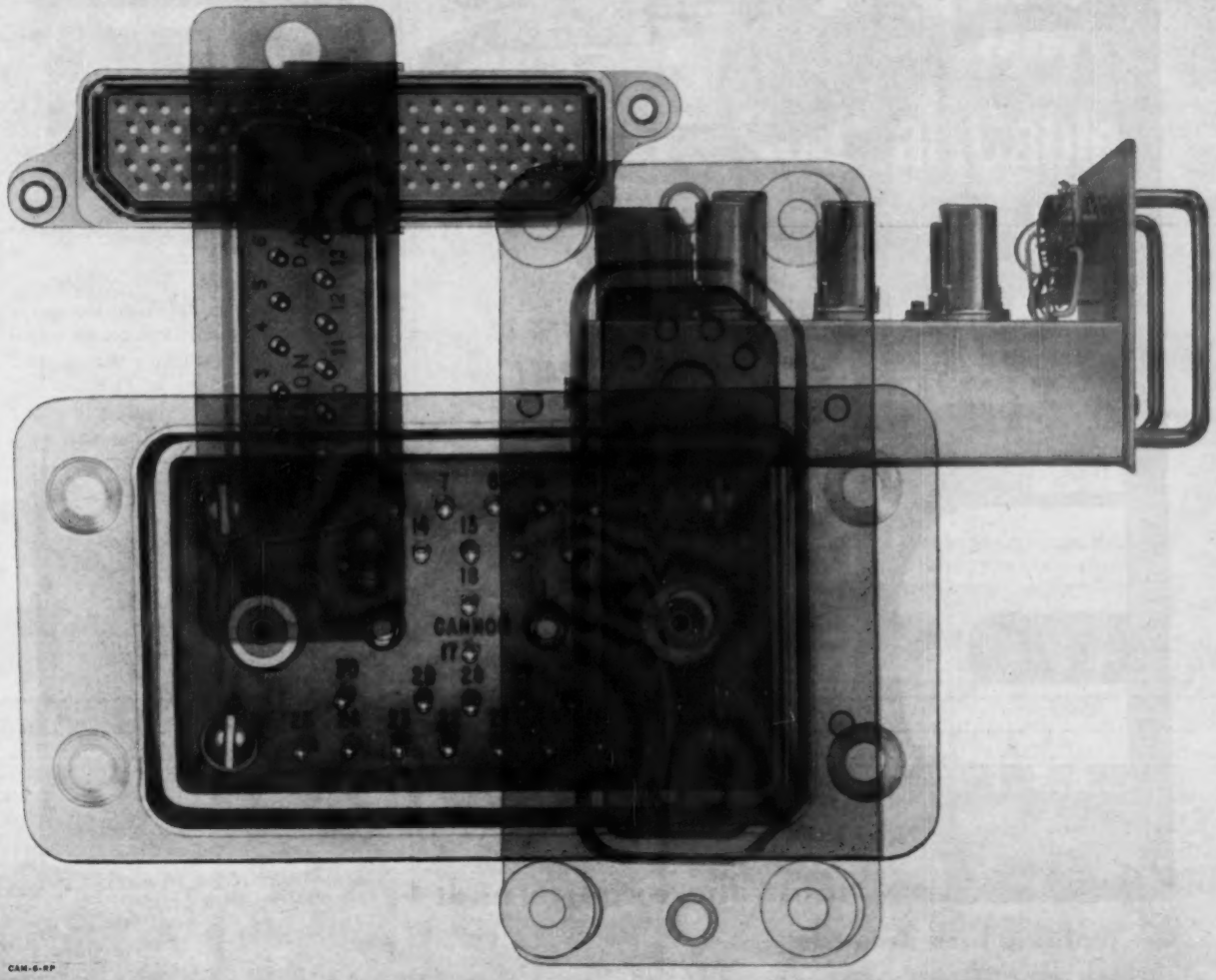
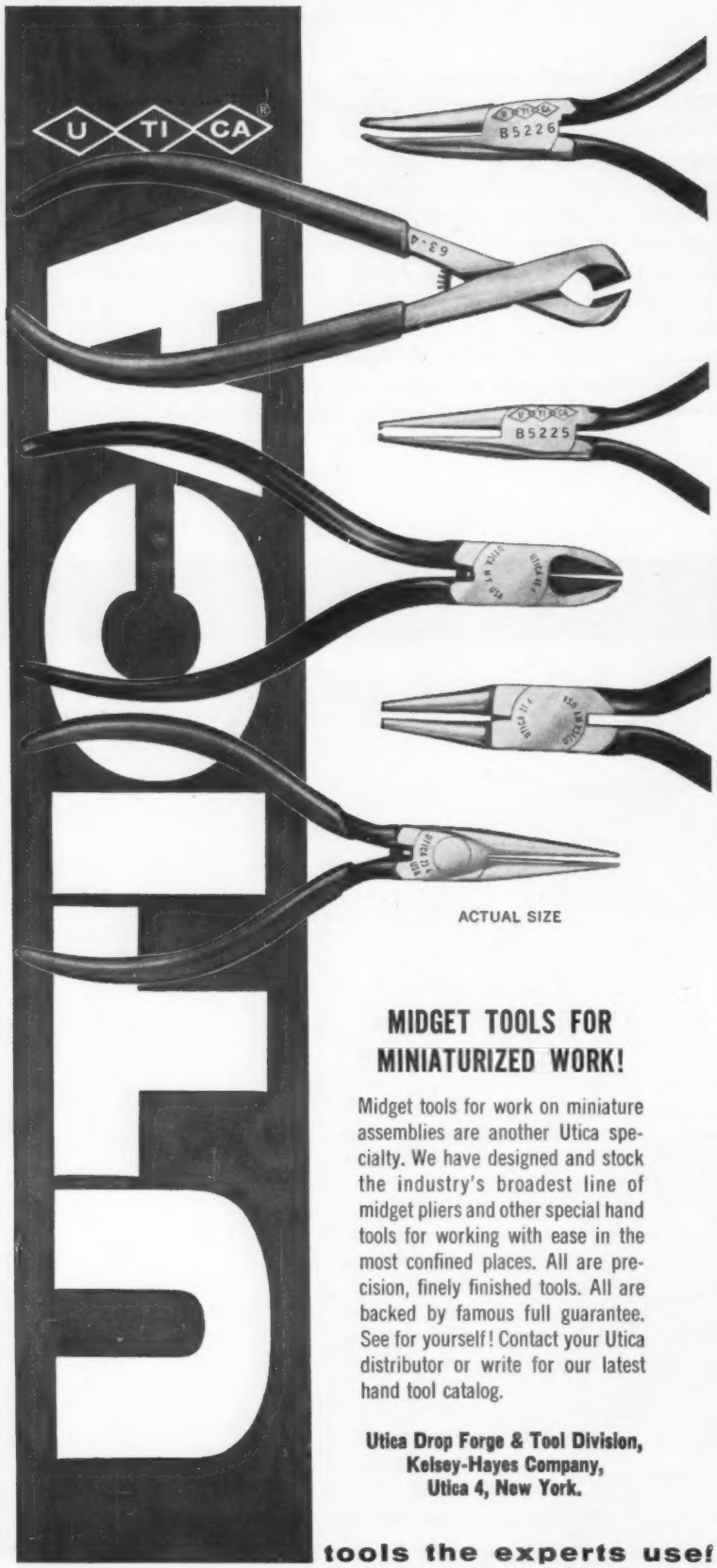


CAN-6-RP



MIDGET TOOLS FOR MINIATURIZED WORK!

Midget tools for work on miniature assemblies are another Utica specialty. We have designed and stock the industry's broadest line of midget pliers and other special hand tools for working with ease in the most confined places. All are precision, finely finished tools. All are backed by famous full guarantee. See for yourself! Contact your Utica distributor or write for our latest hand tool catalog.

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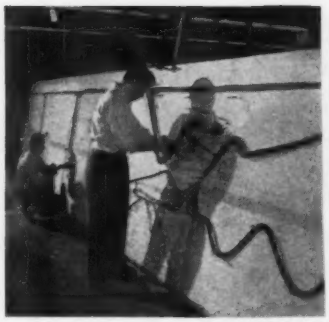
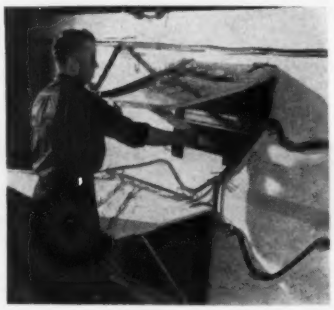
tools the experts use!



Radar harness is over 30 feet long. Cable makers complete lacing



Sections of the board are raised on hinges

continuity buzzer made from a 110-volt stepdown transformer and muffled doorbell. The buzzer's leads are connected to opposite ends of each wire run. A multiple test fixture to handle inspection is under development.

After wiring is completed women solderers finish up the harness with terminals and connectors.

Another of Raytheon's techniques permits harness to be finished on the board, yet provides solderers with a horizontal working surface.

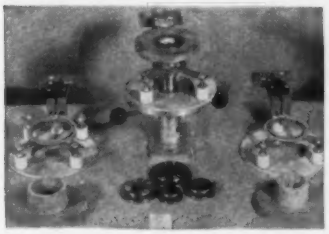
Seated girl strips wire while girl on platform does lugging

Photos, showing preparation of cable harnesses for air route surveillance radars, illustrate this method.

The harness board is made of plywood panels secured to slotted iron A-frames. Sections of the board are cut out at harness locations requiring stripping and soldering work. The cutouts are provided with folding legs and fastened to the main board with hinges. After the cable has been built and laced, the cutouts are raised to form worktables.

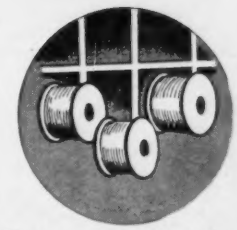
Guide nail heads are wrapped with masking tape to prevent fraying of the cable. Masking tape is also placed around the cutouts to prevent the blueprint from tearing. This method is estimated to cost $75 less per cable than transferring the harness to flat tables for finishing operations.

Brazing Fixture Adapts To Size of Workpiece

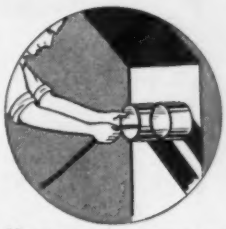


Fixture and work coils for various collar-sleeve assemblies. Adapters are in center

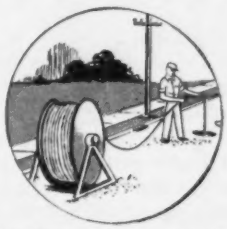
METHOD OF BRAZING assemblies of various sizes with a single fixture has been announced by Induction Heating Corp., Brooklyn, N. Y. To modify the setup, interchangeable work coils and adapter fittings are mounted on the fixture. The pancake type coils are mounted with three bolts. Diameters of the adapter vary to fit the workpiece, but all adapter centers are bored to fit the fixture's elevating pin. With an adapter and coil in place, the pin is raised to loading position. The work is placed on the pin, lowered with a control knob and locked with a clamp knob. The remainder of the brazing cycle is automatic. Threaded studs on the insulators provide vertical adjustment of the coils.



Measures Footage in Stock



Measures Footage used



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Foot-Marked every 2 feet

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3491

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New On The Market

Image Amplifier Tube

POWERFUL DEVICE

A POWERFUL image amplifier tube, called the Astracon, has been announced by Westinghouse Electronic Tube Div., P. O. Box 284, Elmira, N. Y.

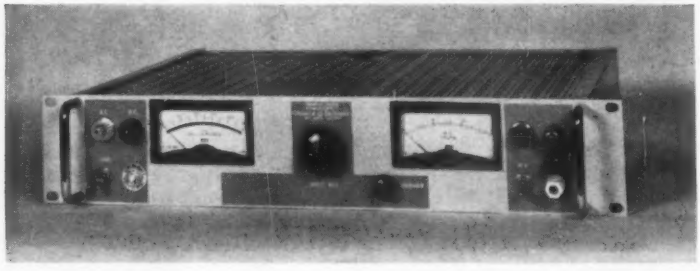
Current pilot production will make several tubes available on a sample basis each month at an initial price of about $7,500 each.

In development for several years, the tube represents the near ultimate in man's ability to amplify ordinary light. It will make visible single particles of light that trigger its ultrasensitive input.

An important use for the tube will be astronomy, where it will increase the light sensitivity of telescope systems. With better views of the most distant galaxies, scientists can conduct spectroscopic analyses to determine if objects are moving away from the earth at increasing or decreasing speeds. Such knowledge is necessary to determine the nature and origin of the universe. In the field of nuclear physics, the tube will make it possible to see the light-trails of high-energy nuclear particles in luminescent crystals.

Heart of the device is a series of four amplification stages. When photons of light strike the light-sensitive end of the tube, electrons are released and propelled by high voltages through a series of thin films, each of which release in turn a greater number of electrons. The resulting image on the face of the tube is thousands of times brighter than the original image.

CIRCLE 301 ON READER SERVICE CARD



Power Supply

FOR TUNNEL DIODES

TUNNEL DIODE Model TD1 transistorized regulated d-c power supply has been developed by Universal Electronics Co., 1720 22nd Street, Santa Monica, Calif., especially for tunnel diode applications. The supply has low output impedance and excellent stability.

Output voltage is 0 to 1½ volts at 0-250 milliamperes. Regulation is 1 millivolt per 10 percent line change, at any rated load; load regulation is 1 millivolt from no load to full load. Ripple is less than 600 microvolts rms. Transient response is less than 50 microseconds. The fully transistorized power supply has multiple Zener diode reference. Remote error sensing terminals are provided to obtain lowest possible output impedance at the load.

Line input is from 105 to 125 a-c, single phase, 60 cps. Advanced style meters for voltage and current are included. Panel size is 3½ by 19 inches for rack mounting; chassis depth is 14¾ inches. Net weight is 23 lbs; shipping weight 55 lbs. Units are available for delivery from stock at $495.00.

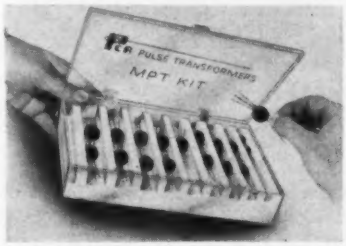
CIRCLE 302 ON READER SERVICE CARD

Three Test Kits

PULSE TRANSFORMERS

THREE NEW test kits covering a wide range of winding ratios and inductances provide a total of 86 test pulse transformers for research, design, breadboarding and prototype experiments. Kits are manufactured by PCA Electronics, Inc., 16799 Schoenborn St., Sepulveda, Calif.

Availability of these handy,



ready-to-use transformers can reduce the time lag experienced by engineers requiring pulse transformers for specific test purposes. The MPT kit of 18 miniature pulse transformers covers a wide range of winding ratios and open circuit inductances for 112 and 521 winding ratios. Approximate pulse widths are from 0.1 through 25 microseconds.

TT Limit Kit of 28 subminiature transistor transformers provides end limit transformers in 112 and 521 winding ratios, useable with pulses ranging from about 0.05 through 5 microseconds. These subminiature transformers are adapta-

WHAT'S BEHIND A BMEWS RADAR?

Years of experience—for as early as 1954, General Electric had conceived and developed radar equipment capable of detecting ballistic missiles at 1,000 miles. This was the forerunner of the AN/FPS-50 surveillance radar being provided by General Electric under subcontract to RCA for the Air Force Ballistic Missile Early Warning System (BMEWS).

The AN/FPS-50 radar equipment, with a range in excess of 2,000 miles, is a singular example of achievement in defense electronics. It is another milestone in General Electric's sustained engineering effort to develop and produce equipment to meet the unprecedented detection problems posed by ICBM's. 176-01

Progress Is Our Most Important Product

GENERAL ELECTRIC

DEFENSE ELECTRONICS DIVISION
HEAVY MILITARY ELECTRONICS DEPARTMENT
SYRACUSE, NEW YORK

ble where space is a critical factor.

TT Range Kit of 40 subminiature transistor transformers provides a sampling of 2, 3 and 4 winding transformers with ratios of 101 and 521. Approximate pulse widths are 0.2 through 3 microseconds.

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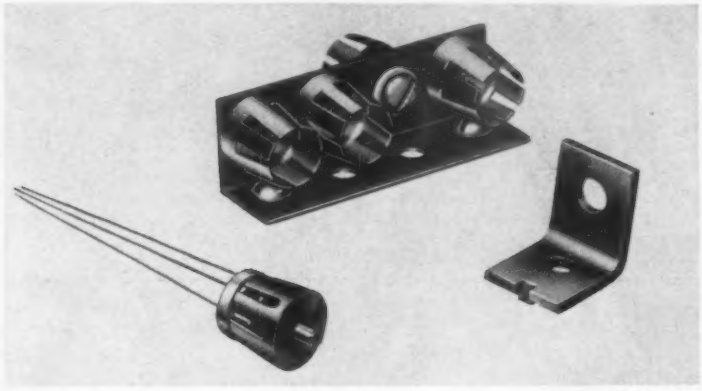


Heat Dissipator

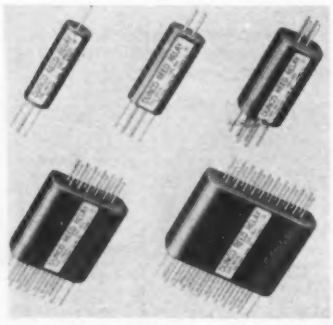
FOR TRANSISTORS

TRANSISTOR heat-dissipating retainer uses all-beryllium copper spring fingers to accommodate diameter variations from 0.305 to 0.335 inch, as found in TO-5, TO-9, TO-11 and TO-39 transistor cases. Adaptability to the transistor case size variations saves engineering time and costs in specifying, stocking and application.

The retainer provides maximum thermal contact with the transistor case, giving efficient transfer of heat from case to dissipator and heat sink. Methods for mounting are suitable for either printed circuit boards or chassis and heat sinks, and give maximum retention in extreme shock and vibration environments. The installation is accomplished by pressing the transistor case into the spring fingers of the dissipator as far as it will go, giving a smooth tension fit. Both types of retainers are available; rivet-attaching and screw-attaching. Both of these attaching methods, with angle mounting brackets, permit single, multiple or back-to-back mounting of the dissipator to printed circuit boards and heat sinks.

Detailed information, performance graphs, etc., are available from IERC Division, International Electronic Research Corporation, 135 West Magnolia Boulevard, Burbank, California.

CIRCLE 304 ON READER SERVICE CARD



Dry Reed Relays

1 TO 20 POLES

COMPLETE line of encapsulated dry reed relays in 1, 2, 4, 12 and 20 pole types has been announced by Struthers-Dunn, Inc., Pitman, N. J., for immediate deliveries. Any combination of normally-open and normally-closed contacts can be furnished.

Of special interest to many users is the fact that break-make action can be furnished to insure non-overlapping of contact closures. Relays may be mounted in any position; contacts have diffused gold surfaces and are completely unaffected by atmospheric contamination.

The relays consist of basic dry reed switches with magnetic reeds operating in an inert gas and sealed in glass tubes. These switches are surrounded by a direct current magnetizing coil and the entire assembly molded in epoxy.

Reed relays are suited to low level and light load switching for hundreds of millions of operations. Exceedingly fast operation meets the needs of many computer and data handling applications. When designed with several coils controlling a single reed, they may also be used as logic bits. Several special types are available for this purpose.

Standard Dunco reed relays are uniformly sized and shaped. All are 1⅞ inch long, exclusive of leads; 3¼ inch long including leads. Widths and depths vary from 0.585 inch diameter for the 1-pole unit to 1 inch depth by 2½ inch width for the 20-pole type. All terminals of encapsulated relays are located to conform to 0.2 inch grid spacing.

CIRCLE 305 ON READER SERVICE CARD

Component Substitutor

44 SELECTIONS

COMPONENT SUBSTITUTOR will substitute for 44 different values of resistors, capacitors, electrolytics, power rectifiers, crystal diodes, power resistors and bias voltages. The Model 500 component substitutor is being manufactured by Mercury Electronics Corp., 77 Searing Ave., Mineola, N. Y.

The device will substitute 20 values of resistors from 33 ohms to 10 megohms, 10 values of capacitors from 0.0001 μf to 0.5 μf, 10 values of electrolytics from 4 μf to 330 μf, power rectifiers up to 55 ma, crystal

How to get accurate data on a small recorder

Ampex's new CP-100 nicely balances four desirable qualities

Compact. Definitely, and a great advantage in trailers, in airplanes, in submarines, or even in regular laboratory use. There's complete front access to everything. All-transistor amplifiers and power supplies cut power needs and keep down the heat – an advantage in tight equipment layouts.

Portable. We'll frankly admit it takes two men to carry it – not just one and a half. But by calling in an occasional fractional man (or by using an accessory dolly) you gain exactly the needed performance that portables have lacked until now. In laboratory use, the CP-100 is "bench-top equipment."

Precise. Let the numbers talk. Though compact, the CP-100 is a full-fledged, uncompromised laboratory recorder: 200 kc response at 60 ips tape speed (and proportional at others); flutter well within telemetered-data requirements; intermodulation distortion so low it never adds spurious data of its own.

Universal. Yes, in numerous ways. The CP-100 isn't fussy about power; takes 115 or 230-volt AC at 50, 60 or 400 cycles or 28-volt DC from batteries or generator. Kinds of data: direct or FM-carrier, by interchangeable plug-in amplifiers. And it records and plays back as well.

The essential data

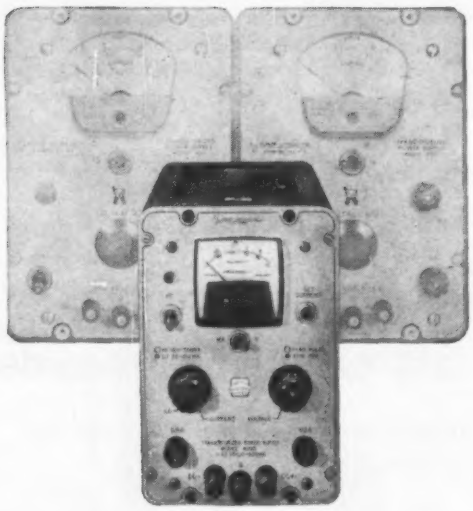
Model: CP-100 Compact Recorder/Reproducer. *Reel size and tape width:* 10½-inch reels with ½- or 1-inch tape (as specified). *Types of recording:* direct or FM carrier by plug-in interchangeable amplifiers. *Tape speeds:* 60, 30, 15, 7½, 3¾ and 1⅞ ips. *Frequency response:* direct, 300 to 200,000 cps ± 3 db at 60 ips; FM carrier, 0 to 20,000 cps at 60 ips; response at other speeds proportionate. *Tape compatibility:* yes, with Ampex FR-600, AR-200 or interchangeable with FR-100, FR-1100, 300 and 800 series.

May we tell you more? Please write

AMPEX

AMPEX DATA PRODUCTS COMPANY

Box 5000 • Redwood City, California • EMerson 9-7111



CONSTANT VOLTAGE
CONSTANT CURRENT

- +

FROM THE SAME TERMINALS!

The Power Designs Inc. Model 4005 Power Supply adds a new dimension to the application of d-c sources for laboratory instrumentation. Truly universal, the Model 4005 may be operated as a *constant voltage* source, a *constant current* source, a *constant voltage* source with *automatic current limiting* or a *constant current* source with *automatic voltage limiting*.

The Model 4005 employs semiconductor devices exclusively in a new proprietary circuit called ..... AMBITROL* V-I

AMBITROL* is a dual regulator system permitting continuous control of voltage or current with automatic electronic cross-over to either mode of operation.

The supply also features remote voltage programming, dual concentric controls for both coarse and fine adjustment of voltage or current and the HEATRAN® circuit for electronic control of power transistor dissipation.

*TM applied for.

†$143.50
F.O.B. FACTORY

MODEL 4005 SPECIFICATIONS

INPUT: 105-125 volts, 55-440 cycles single phase.
TEMPERATURE: Continuous duty at full load 0-50° C. ambient
POLARITY: Positive or negative output terminal may be grounded
DIMENSIONS: 5¾" W x 8⅝" H x 11¾" D.

CONSTANT VOLTAGE

Range: 1-40 vdc, 0-0.5 amperes.
Regulation: .05% or 10 millivolts max. for line or load variations.
Ripple: .001% or 500 microvolts max.
Response Time: Less than 50 microseconds.
Source Z: 0.1 ohms to 20 kc, 0.5 ohms to 1 mc.

CONSTANT CURRENT

Range: 25 to 500 milliamperes.
Voltage compliance: Output current constant to full rated output voltage of 40 volts.
Regulation: 0.05% or 250 microamperes max., for line or load variations.
Ripple Content: .01% or 25 microamperes max.
Source Impedance: 100,000 ohms approx.

†Prices subject to change without notice.

Power Designs inc. 1700 SHAMES DRIVE WESTBURY, NEW YORK

EDgewood 3-6200 (Long Distance Area Code 516)

92 CIRCLE 92 ON READER SERVICE CARD

diodes, power resistance continuously variable to 5000 ohms, and bias voltages continuously variable up to 15 volts either polarity.

Housing is a slope front, hammertone finish steel case with specially designed handle that folds back to serve as a rest, so that the instrument can be used in a tilted position.

The device is available from electronic parts distributors at $29.95.

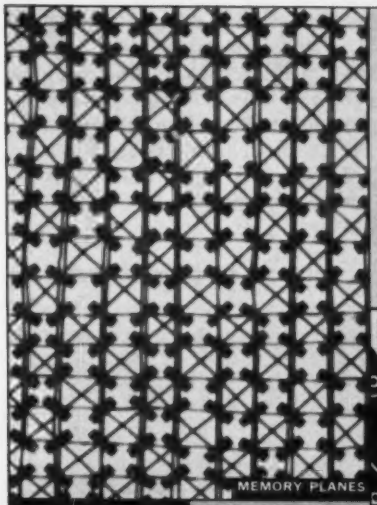
CIRCLE 306 ON READER SERVICE CARD

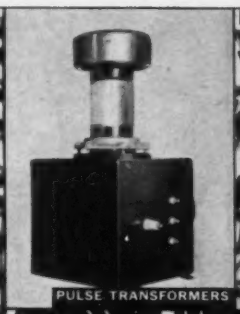
Micro Delay Plug-In

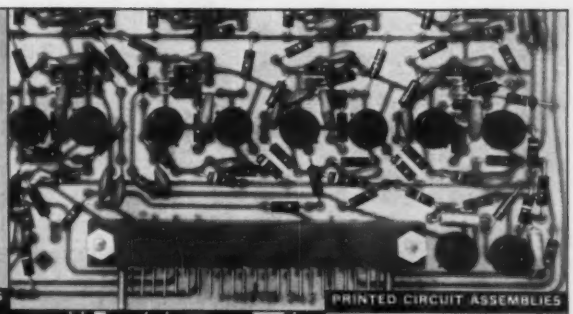
PRECISE TRIGGER DELAY

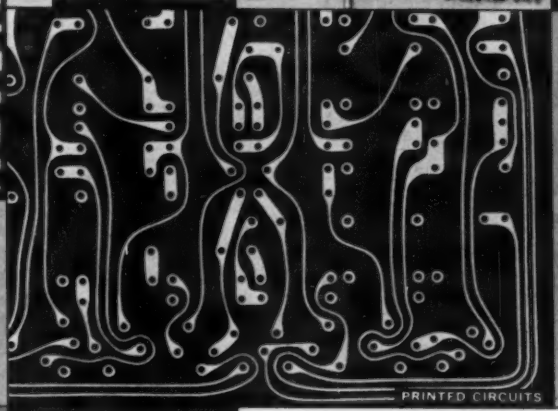
MICRO DELAY plug-in (Type 4209) has been announced for the Du Mont 425 direct digital readout high frequency oscilloscope. The new plug-in provides precise trigger delay from 0 to 100 nanoseconds and resolution within 0.1 manosecond. A ten-turn helical delay line with a four-digit inline readout is provided for simplicity. The unit is inserted electrically into the external trigger channel of the 425, and a selector switch permits trigger source selection from the internal signal, from an external source, or from the internal fast rise generator. A mercury switch millimicrosecond fast rise pulse generator is included in the plug-in to provide a 50-ohm source impedance test signal for external apparatus.

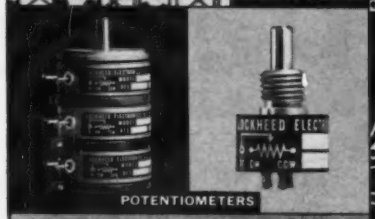
The plug-in unit may be used as a precise, passive time standard to make accurate incremental time measurements on fast rise times, and phase measurements on high frequency sine waves from less than 10 Mc to greater than 40 Mc. The unit is one of a number of plug-ins announced for the 425 oscilloscope to give it versatility as

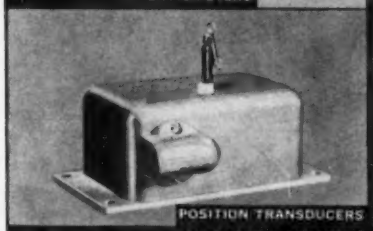


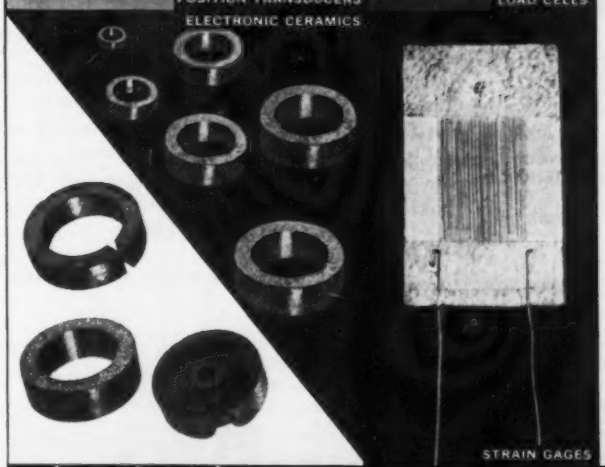












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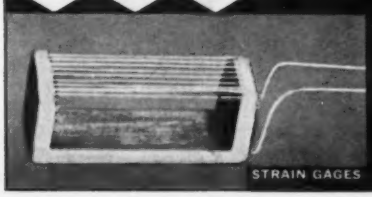


For information on Lockheed Electronics, write:
Marketing Branch – Lockheed Electronics Co.
Avionics & Industrial Products Division,
6201 East Randolph Street,
Los Angeles 22, California
Or phone: OV 5-7070

H-LAB REGULATED POWER SUPPLIES

Auto-Series* and Auto-Parallel* Operation

***One-knob Master Control · Automatic Current Equalizing**
Automatic Voltage Equalizing · Full Range Control From Any Selected Module

For the ultimate in Regulated Power Supplies, look to H-Lab Model 865, a standout in every detail. The compact 865 is suitable for either bench or relay rack operation. This trouble-free unit features automatic transition to a current-limiting mode of operation. The current-limit is adjustable by means of a front-panel knob. This power supply is short-circuit proof, as are all H-Lab transistor supplies. In addition, the current-limit circuit of the 865 can be set for exactly the value of current which will provide maximum protection to the load device.

H-Lab Regulated Power Supplies are preferred by major laboratory and O.E.M. consumers. H-Lab Model 865 is priced at **$185** (with case)

SPECIFICATIONS

Output: 0-40 volts, 0-0.5 amps.
Input: 105-125 VAC
50-440 cps
Load and Line Regulation:
5 millivolts.
Size: 8" W x 5 1/16" H x 8" D
(with case)
Weight: 11 lbs. (with case)
Remote Programming

OTHER PRECISE, VERSATILE AND COMPACT POWER SUPPLIES INCLUDE:

Model	E Out	I Out	Bench Model	Rack Model	Continuously Variable	Special Comments	Price
400D	150-315	0-1.5		x	No	Vacuum Tube Type	$595.00
520A	0-36	0-20		x	Yes	High Efficiency	575.00
800A-2	0-36	0-1.5	x	x	Yes	Dual Output	580.00
800B-2	0-36	0-2.5	x	x	Yes	Low Cost Medium Current Supply	339.00
802B	0-36	0-1.5		x	Yes	Dual Output Remote Sensing	580.00
806AM	0-20	0-2.0		x	Yes	Remote Sensing Remote Programming	350.00
808A	0-36	0-5		x	Yes	Constant E/Constant I	425.00
810A	0-50	0-7.5		x	Yes	Remote Sensing	895.00
812C	0-32	0-10		x	No	Remote Sensing	550.00
855	0-18	0-1.5	x	x	Yes	Can be connected in series or parallel	175.00
880	0-100	0-1.0	x	x	Yes	Wide Voltage Span	375.00

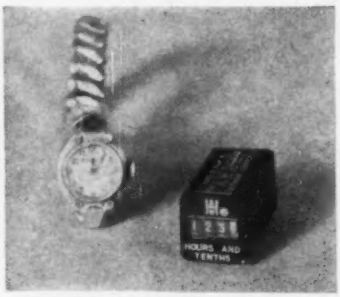
Write on your letterhead for new, illustrated catalog describing the complete H-Lab line.

H-LAB **HARRISON LABORATORIES, INC.**
45 Industrial Road • Berkeley Heights, New Jersey

a laboratory instrument.

For complete specifications on the micro delay and other plug-ins for the 425 oscilloscope, write Instrument Sales Department, Allen B. Du Mont Laboratories Divisions of Fairchild Camera and Instrument Corporation, Clifton, New Jersey.

CIRCLE 307 ON READER SERVICE CARD



Elapsed Timer
FOUR DIGIT READOUT

ELAPSED timer has ½ inch square face and a depth of 1⅞ inch. The timer operates on 400 cps and is available in two models, one reading to 999.9 hours and one reading to 9999 hours. White numerals on a lusterless black background give good readability. The timers are manufactured by the A. W. Haydon Company, Waterbury, Conn.

The timer uses a 115 volt, 400 cps hysteresis motor ⅜ inch in diameter by ⅝ inch long. Power consumption is less than ½ watt; torque is 0.005 ounce-inch; horsepower is 1.5 x 10^{-6}; weight is 1/9 ounce. The motor has also been used in a miniaturized recycling timer.

CIRCLE 308 ON READER SERVICE CARD

Dial Assembly
PANEL-MOUNTED

THETA INSTRUMENT CORP., 520 Victor St., Saddle Brook, N. J. For use in testing aircraft indicators, a

appearances are not deceiving

THIS P&B 10-AMP RELAY IS AS RELIABLE AS IT LOOKS

Our AB relay looks rugged . . . and it is. You can specify it for 10 amp switching and confidently expect 100,000 cycles. Yet it is compact, easily mounted, and does not require special handling. Installation is simple, using your preference of screw terminals (adapters), quick connects, or dip soldering.

Designers specify the AB for air conditioners and other products where dependable, continual service is paramount.

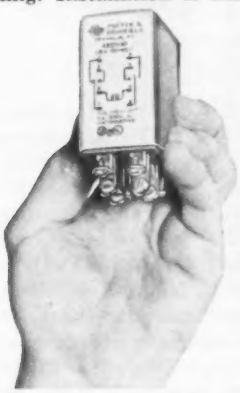
These standard AB and ABC relays are listed by Underwriters' Laboratories and Canadian Standards Association:

Type	Arrangements	Type	Arrangements
AB7AY	DPST-NO	ABC7AY	DPST-NO
AB8AY	DPST-NC	ABC8AY	DPST-NC
AB11AY	DPDT	ABC11AY	DPDT

Coil voltages: 6, 12, 24, 115 and 230 volts AC, 50/60 cycle.
Contact rating 10 amps. 115 volts AC or 5 amps. 230 volts AC noninductive.

U/L File E-29244 CSA No. 15734

Write for complete data or contact your nearest P&B sales engineer.



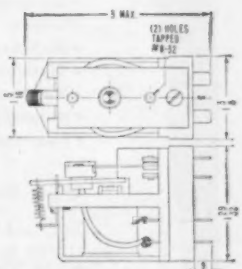
ABC Series—AB series can be supplied enclosed in sturdy metal dust cover, 1³¹⁄₆₄" x 2²³⁄₃₂" x 2³⁄₃₂".

AB AND ABC RELAYS ENGINEERING DATA

GENERAL:
Insulation Resistance: 100 megohms minimum.
Life: 3 million cycles (mechanical).
Breakdown Voltage: 1500 volts rms between all elements and ground.
Temperature Range: DC: −55 to +45°C.
AC: −55 to +45°C.
Weight: AB—5 ozs. ABC—7 ozs.
Terminals: Fit ¼" quick-connect terminals, or may be applied to printed circuits using dip soldering. Screw adapters furnished on request.
Enclosure: ABC: Heavy duty dust cover.
Dimensions: 1³¹⁄₆₄" x 2²³⁄₃₂" x 2³⁄₃₂".

CONTACTS:
Arrangements: DPDT
Material: ¼" dia. silver. Other materials available.
Load: 5 amps at 230 volts AC or 10 amps at 115 volts AC noninductive.
10 amps at 28 volts DC.

COIL:
Voltage: DC: 6 to 110 volts.
AC: 6 to 230 volts.



Power: DC: 2 watts nominal.
AC: 6.4 volt-amps.
Resistance: 35,000 ohms max.
Duty: Continuous: DC coils will withstand 6 watts at +25°C.

MOUNTINGS:
AB: Two 8-32 tapped holes on 1¼" centers.
ABC: One 8-32 stud ⅜" long and locating tab.

P & B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

AMF **POTTER & BRUMFIELD**

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY, PRINCETON, INDIANA

IN CANADA: POTTER & BRUMFIELD CANADA LTD., GUELPH, ONTARIO

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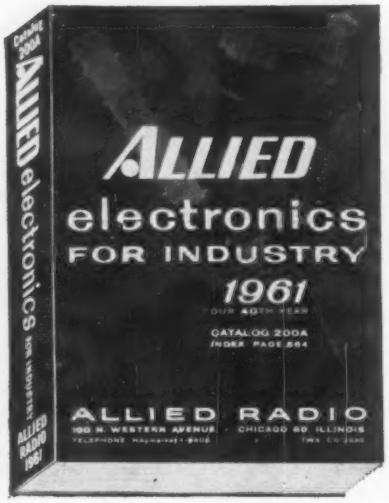

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new 360 deg dial assembly for synchros and resolvers is offered. The unit mounts on any test panel and accepts the synchro without further fixturing. It provides inputs to synchro-type indicators and measures the output position from transmitter-type indicators. Specifications: o-d, 5 in.; accuracy, 5 min.; readability, 6 min. Price is $85.

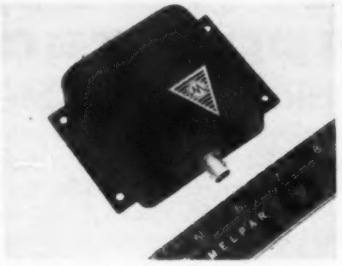
CIRCLE 309 ON READER SERVICE CARD

Elapsed Time Indicator

DIRECT CURRENT

HOUSTON FEARLESS CORP., 11800 W. Olympic Blvd., Los Angeles 64, Calif., has available a direct current elapsed time indicator, subminiaturized and accurate to 1 percent under severe environmental conditions. The "Alert" meets or exceeds MIL-E-5272C at: −65 F to +160 F; 100,000 ft altitude; 10 to 500 cps vibration at 10 g's. Measures 1 in. diameter by 1¼ in. depth, weighs 2 oz, 20 to 30 v d-c. Offered in 1,000 and 10,000-hr models, the "Alert" provides accurate test records or operational life warning for components, modules, or systems.

CIRCLE 310 ON READER SERVICE CARD



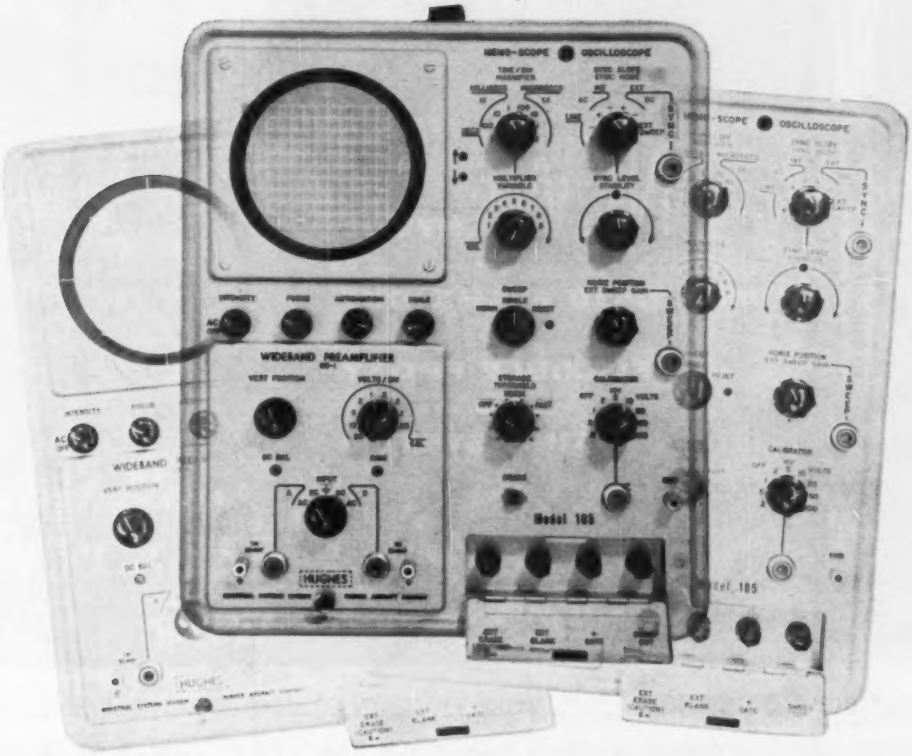
UHF Filter

WEIGHS ONLY 4 OZ

MELPAR, INC., 3000 Arlington Blvd., Falls Church, Va. Using conventional and printed circuit techniques, a new line of bandpass filters are available in the frequency range from 200 to 1,500 Mc. Occupying less than 13 cu in. and weighing only 4 oz, multistage filters having either maximally flat or Tchebycheff response characteristics provide signal rejection up to 35 db at one bandwidth from the filter center frequency. Bandwidths range from less than 5 percent to greater than 20 percent. Maximum pass-band insertion loss is held to less than 1db. These filters are de-

All New Hughes 10 mc MEMO-SCOPE® Oscilloscope

2 PRECISION INSTRUMENTS IN 1



CONVENTIONAL MODE

- DC to 10 mc Band Pass
- Sweep Range: 0.1 μ secs/division;
  5 X Magnifier for speeds to .02 μ secs/division;
  Multiplier for sweeps long as 10 secs/division
- Rise Time: 35 nanoseconds
- Built-in Delay Line (0.25 μ secs)
- Numerous Trigger Selections
- Electron Beam Position Indicators
- Plug-in Preamplifiers

STORAGE MODE

(All features of Conventional Mode, PLUS:)

- 1,000,000"/sec Writing Speed
- Unlimited Storage Time
- Fast Erase (Less than 150 millisecs)
- X-Y Plotting
- Single Shot Trigger
- Photograph or Trace Directly Off Scope Face

This unique, high frequency instrument combines the benefits of a precision laboratory oscilloscope and a Hughes storage oscilloscope. The new Model 105 MEMO-SCOPE oscilloscope provides high frequency response (10 mc) and fast writing speed (1,000,000 inches/sec). And, in addition, it can store non-recurring transients on the scope for any desired period, keeping them visible until intentionally erased.

For complete details or an interesting demonstration of the MEMO-SCOPE oscilloscope and its many accessories, write, teletype (TWX INGL 4117) or call collect:
HUGHES Industrial Systems Division, P.O. Box 90904, International Airport Station, Los Angeles 45, California.
For export information, please write:
Hughes International, Culver City, California.

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CIRCLE 97 ON READER SERVICE CARD 97

HYSOL 15-032, a new flame-retardant epoxy casting system, snuffs out immediately upon removal from Bunsen burner flame.

Non-burning by ASTM D635-56T standards, and self-extinguishing according to MIL-I-16923C and MIL-T-27A tests, HYSOL 15-032 is flexible to withstand thermal shock.

HYSOL 15-032 Flame-Out Epoxy Casting System is recommended for use on transformers and other electrical/electronic components requiring its unique characteristics.

For complete information write for Bulletin E-215.

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HYSOL OF CALIFORNIA Los Angeles, California
HYSOL (CANADA) LTD. Toronto, Ontario

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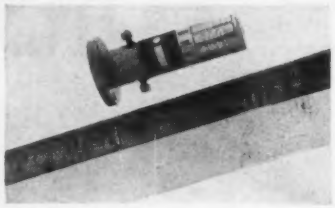
signed to meet the environmental requirements of MIL-E-5400 and the vibration requirements of MIL-E-5422.

CIRCLE 316 ON READER SERVICE CARD



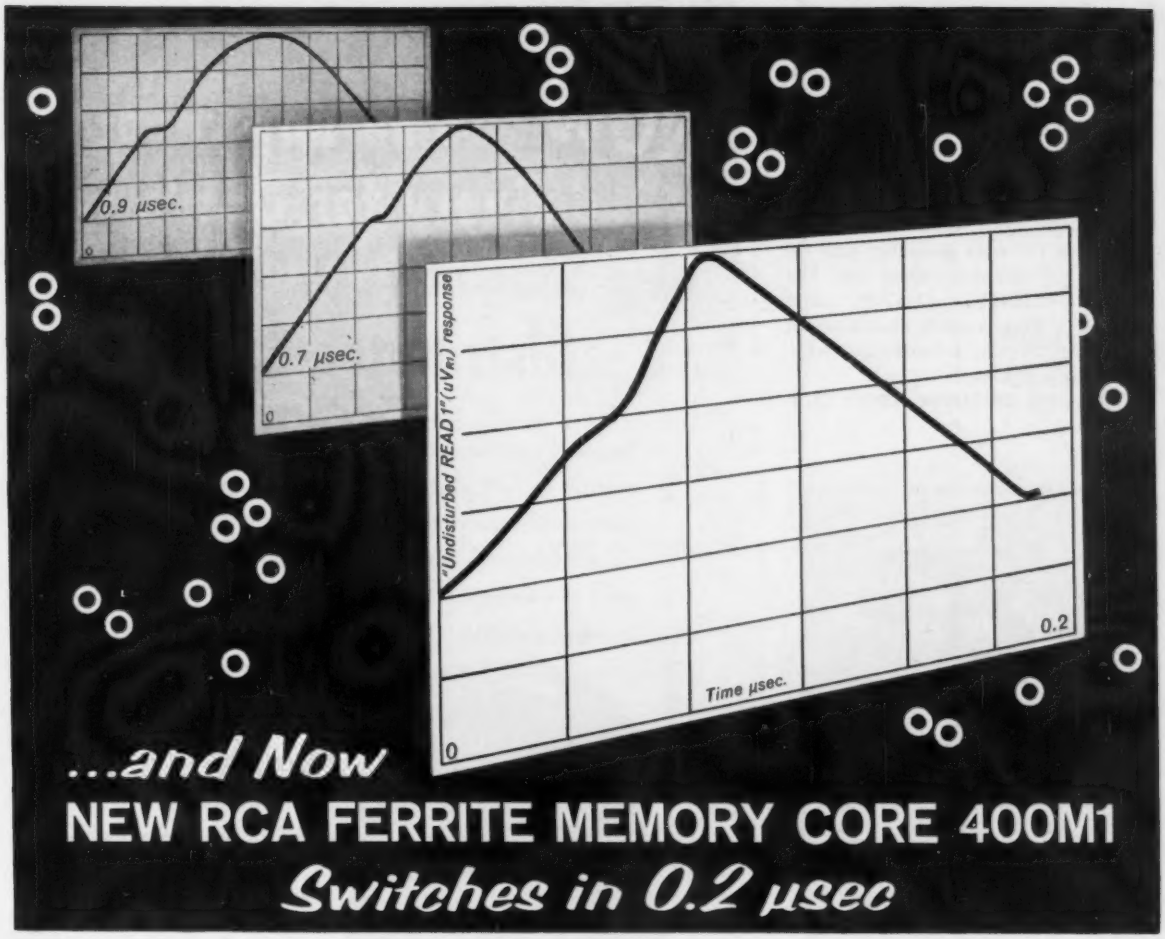
Inertia Switch
ACCURATELY PRESET

INERTIA SWITCH, INC., 311 W. 43rd St., New York 36, N. Y. Model 6UO-115 is accurately preset to respond to acceleration forces from 1 g to 25 g within a tolerance of ± 5 percent of setting. It is designed with only one moving part, a precision-ground steel ball held against a solid base by a uniform magnetic field. When the opposing force of acceleration exceeds the magnetic force, the ball moves to close a normally open electrical contact. The switch meets all environmental specifications of MIL-E-5272, including an operation range of −65 F to +200 F. Miniature switches of this type can be utilized for control or limiting applications when actuated by acceleration, deceleration, impact and/or shock.

CIRCLE 317 ON READER SERVICE CARD

Coax Termination
VERY HIGH VOLTAGE

COMPONENTS FOR RESEARCH, INC., 979 Commercial St., Palo Alto, Calif. Designed for tank mounting and for either cable-to-air or cable-to-oil operation, a series of terminations for RG coaxial cable have insulating bodies of vacuum-cast



Ultra high-speed microminiature memory core makes possible a memory cycle approaching 1 μsec in impulse switching circuits at low driving currents

Now you can achieve a memory cycle approaching 1 μsec. in your computer designs with new RCA memory core 400M1 (formerly XF 4697). Specifically designed for use in an impulse switching mode of operation, the new core has a switching time of 0.2 μsec. at a read driving current of 380 ma-turns.

Size: The new RCA core is microminiature in size making possible substantial savings in space and weight of planes and stacks. It measures 0.030 inch outer diameter, 0.018 inch inner diameter, and is 0.010 inch thick.

Strength: Despite its minute size, the RCA 400M1 core is rugged. It will not fracture when subjected to a compressive force of 100 grams applied between parallel plane surfaces normal to core diameter.

Systems Engineering Service: Your local RCA Field Representative is prepared to provide you with a completely coordinated service, including transistor, ferrite and memory-system application assistance. Call him today. For technical literature, write RCA Commercial Engineering, Section J-19-NN-1, Somerville, N. J.

Nominal Operating Characteristics at 25°C

Types	Full Read Driving Current (I_R) ma	Full Write Current (I_{FW}) ma	Impulse Write Current (I_{IW}) ma	Digit Write Current (I_{DW}) ma	Read Pulse Rise Time (t_r) μsec.	Full and Impulse Write Current Rise Time (t_r) μsec.	Digit Write Pulse Rise Time μsec.	Switching Time (t_s) μsec.	Response: Undisturbed Read 1 (uV_{R1}) mv	Response: "Disturbed 0" (dV_0) mv
400M1 (XF4697)	380	280	180	100	0.1	0.08	0.15	0.210	50	8

RCA SEMICONDUCTOR & MATERIALS DIVISION FIELD OFFICES

EAST: 744 Broad Street, Newark 2, N. J. HUmboldt 5-3900
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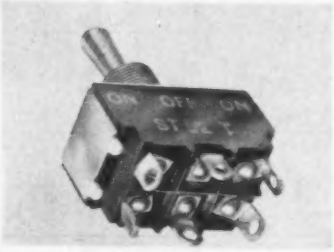
epoxy and feature internal electrical stress control. Example illustrated is rated at 75 Kv and for minimum corona level with a flashover voltage of 127 Kv peak. Other models are available to ratings beyond 300 Kv d-c and for use in air, oil or vacuum. Mechanical design provides for easy assembly and removal of coaxial cables in the series RG14/U, RG17/U, and RG19/U. The example shown has a length of 10½ in., a flange diameter of 5½ in. and weighs 7½ lb.

CIRCLE 318 ON READER SERVICE CARD



Toggle Switch
BARRIER DESIGN

KULKA ELECTRIC CORP., 633-643 So. Fulton Ave., Mt. Vernon, N. Y. A complete line of toggle switches meeting MIL-S-3950A and MIL-S-6745 specifications and incorporating a barrier configuration between terminals is available. The barrier design increases leakage paths and at the same time provides a safety factor in event of a loose connection. Line includes models for all common circuit characteristics based on dpdt or single-throw configurations, including momentary close or open functions.

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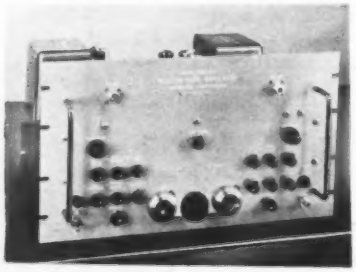

Beacon Code Simulator
DOUBLE-PULSED

MICRO-TEL CORP., 2127 Maryland Ave., Baltimore 18, Md. Model PSG-

NOW same day capacitor delivery for OEM's with **new** Sangamo "OFF-THE-SHELF" Distributor Service!

Sangamo's Industrial Distributor policy offers you the fastest possible service when purchasing mica, paper, plastic film and electrolytic capacitors. Quick local delivery is assured because these Authorized Sangamo Industrial Distributors maintain a stock of commercial and military capacitors available for your emergency requirements at factory prices. Your order is filled as quickly as a capacitor can be taken off the shelf and delivered.

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MISSOURI
Jones Electronic Sales, Inc., Kansas City, 11

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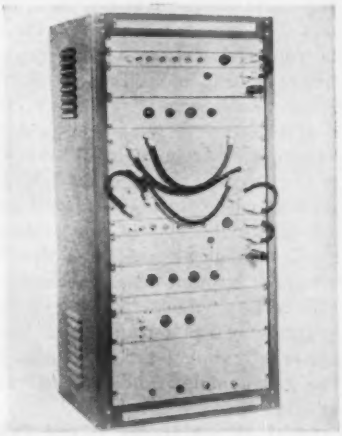
10A beacon code simulator is a double-pulsed microwave signal source covering 2,700-2,900 Mc and 5,100-5,900 Mc. Pulse width can be adjusted from 0.3-10 μsec, pulse spacing from 0-100 μsec, and prf from 10-2,000 pps. Parallel sets of pulse controls can be used to preset all pulse parameters in either C or S band. 100 mw of pulse or c-w power is available in both bands through 40 db variable attenuators for sensitivity measurements. The entire instrument is housed in a 19 in. by 10½ in. by 15 in. cabinet and will operate from 60 to 400 cps power source. Primary purpose of the instrument is to check sensitivity and pulse decoding circuitry of radar beacons.

CIRCLE 320 ON READER SERVICE CARD



Double Pulse Generator
HIGH-SPEED

RUTHERFORD ELECTRONICS CO., 8944 Lindblade St., Culver City, Calif. Model B5-2 is a 10 Mc double pulse generator. The two pulse trains are derived from a single oscillator and have constantly variable repetition rates from 1 cps to 10 Mc, in seven ranges, with a rise and fall time no greater than 8 milliμsec. Pulse width is continuously variable from 20 milliμsec to 12.5 μsec in four stages, maximum width being limited to about 20 percent of the pulse to pulse spacing. Both pulses can be delayed individually up to 500 μsec by use of a delay-multivibrator type circuit. The use of coaxial delay lines permits one of the two main output pulses to be delayed up to 0.4 μsec in steps of

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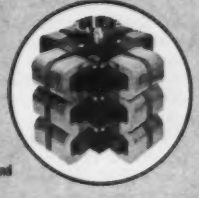
When you think of high vacuums, you have to think clean... and if you think of exceptionally clean vacuums, without fluids or other contaminants, you have to think of UlteVac electronic vacuum pumps —made by Ultek, the only manufacturer devoted exclusively to the technology of fluidless vacuum pumping. UlteVac pumps, using no moving parts, hot filaments, or refrigeration, produce vacuums to 10^{-9} mm Hg and below; operate unattended for months, invulnerable to power failure. System vacuum automatically measured.

ULTEVAC® ELECTRONIC HIGH-VACUUM PUMPS

1 to 1000 Liters/Second



Series 327 Pump
270 Liters/Second

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ELEMENTS FOR ALL APPLICATIONS AS WELL AS COMPLETE TRANSDUCER ASSEMBLIES FOR MOST APPLICATIONS, SUCH AS UNDERWATER SOUND AND VARIOUS ORDNANCE AND MISSILE DEVICES.

Sprague-developed mass production and quality-control techniques assure lowest possible cost consistent with utmost quality and reliability. Here too, complete fabrication facilities permit prompt production in a full, wide range of sizes and shapes.

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THE MARK OF RELIABILITY

0.005 μsec without further restriction. Pulse delay is also limited to approximately 20 percent of the pulse spacing.

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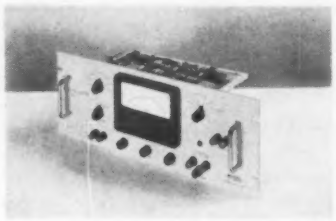

Null Voltmeter
TRANSISTORIZED

HYDEL, INC., 223 Crescent St., Waltham, Mass., announces a completely transistorized battery or line-operated null voltmeter with full scale range of 300 v, 30 v, 3 v, and 300 mv. With accuracy to 1½ percent of full scale, it measures the in-phase fundamental component of small a-c signals, particularly the null or error signals common to suppressed-carrier control systems. A 1 percent zero-center, mirror-scale is used. Reference, input and power input circuits are isolated from each other and from the instrument ground case to eliminate ground-loop effects. Frequency selection, meter zeroing and gain phase adjustment are set simply at the front panel, and no external equipment is required.

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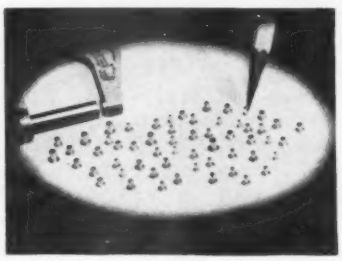
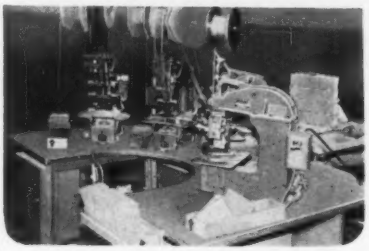


Precision Eyelets
AID MINIATURIZATION

RAMCO MFG. CO., 540 Westfield Ave., W. Roselle Park, N. J. Miniature eyelet sizes in an o-d range of from 0.046 in. to 0.100 in. are available in stock sizes for applications in electronic tubes, rectifiers, diodes, electrical switches, printed circuitry and many other devices. These eye-

DYNASERT

Speeds Component Inserting to 10 Times in PW Boards



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CIRCLE 202 ON READER SERVICE CARD

lets, made from pure nickel, stainless steel, copper, steel nickel plated or brass, have many uses in the manufacture of small components. They are precision made to extremely close tolerances and guaranteed perfect. Special burnishing process accounts for extra smooth free-running parts in eyeleting machine raceways. Specification chart showing many sizes with samples attached in small transparent bags is available free on request.

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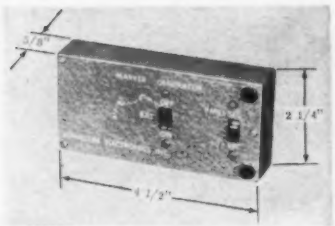


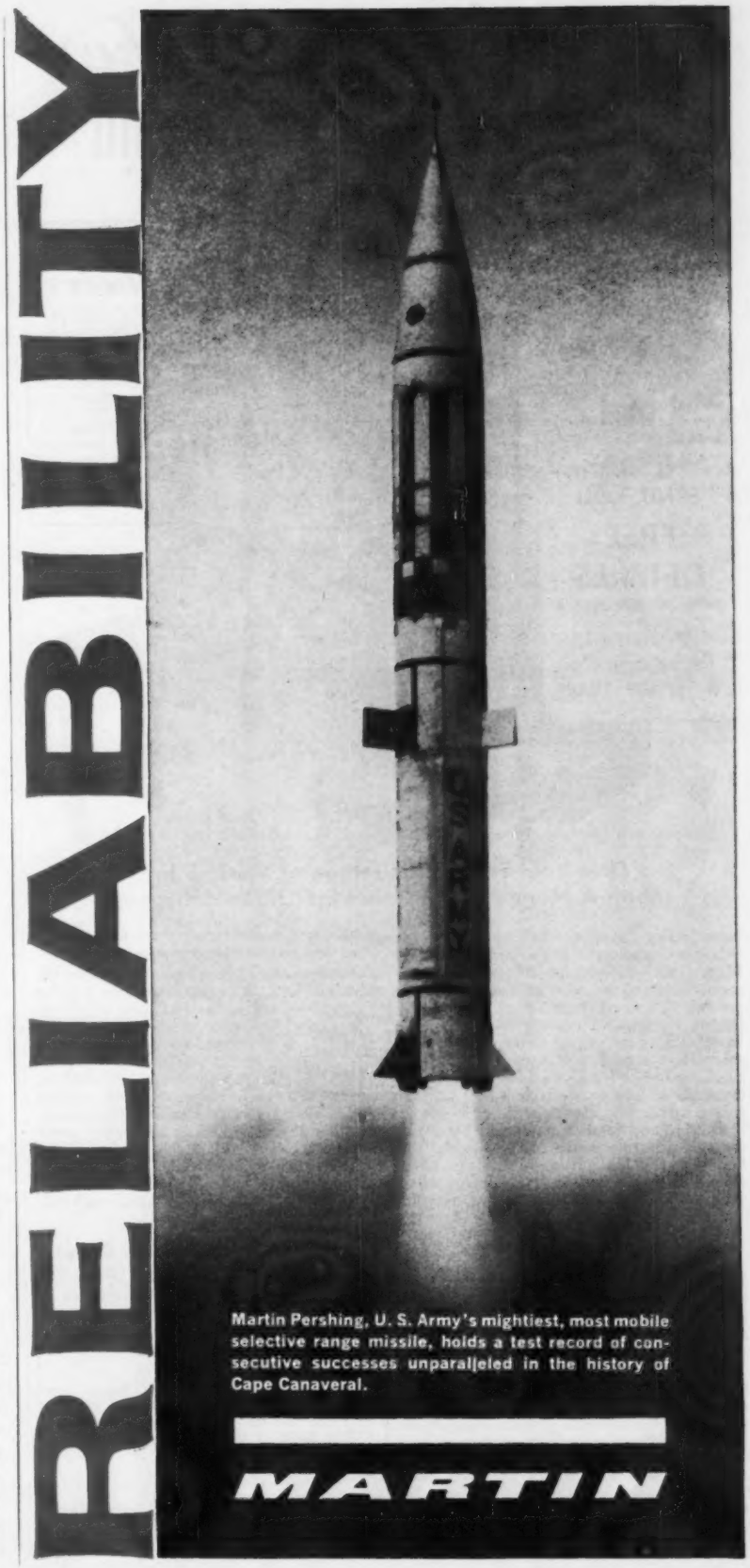
Marker Generator
TRANSISTORIZED

JOHNSON ELECTRONICS, INC., P.O. Box 1675 Casselberry, Fla. New transistorized marker generator provides pulse to calibrate oscilloscope sweep. Model 100MG1 weighs only 8 oz, operates on its own self-contained 9 v battery for 1 year of normal use. No warm-up time is necessary. Convenient switch provides instant change from 10 μsec to 1 millisec pulse.

CIRCLE 324 ON READER SERVICE CARD

Silicon Transistor
HIGH POWER

SILICON TRANSISTOR CORP., Carle Place, N. Y. Types 2N1487,-8,-9 and -90 are diffused junction, *npn* high power silicon transistors suitable for applications in power converters, power supply regulators, relay replacements and controls, as well as d-c and servo amplifiers. Temperature range is from — 65 C to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MARTIN

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☐ Please send me FREE full-color booklet and other literature on the Schober organs.

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+ 175 C. Power dissipation at mounting flange temperature of 25 C is 60 w. These types feature a high beta and low saturation resistance. The range of beta for 2N1489 and 2N1490 is from 25 to 75 with saturation resistance of maximum 0.67 ohm measured at 1.5 amperes. The new series are hermetically sealed in welded metal cases and have dimensions which conform to the JEDEC No. TO-3 outline. The collector is in electrical contact with the case.

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A-C Instruments
TAUT-BAND SUSPENSION

WESTINGHOUSE ELECTRIC CORP., P. O. Box 2099, Pittsburgh 30, Pa., offers new 100-deg a-c ammeters and voltmeters (KA-251) using the taut-band suspension system. They are available from 0.005 up to 75 amperes and from 5 to 800 v self-contained. They replace the instruments using pivot and jewel bearings and air chamber damping. Taut-band construction eliminates rolling and sliding friction and enables instruments to withstand severe shock without affecting their accuracy. In addition, the ammeters and voltmeters are designed for easy calibration adjustment and have magnetic damping.

CIRCLE 326 ON READER SERVICE CARD

Delay Lines
LUMPED CONSTANT

ALLEN AVIONICS, INC., 255 E. 2nd St., Mineola, L. I., N. Y. Employing

subminiature inductors and temperature compensating capacitors, these high density, lumped constant delay lines offer the user the greatest stability in electrical characteristics over the temperature range from −55 C to +105 C. These lines are particularly suited for use in missile, airborne and commercial computers and data processing equipment. They are packaged in 3 types of cases: hermetically sealed metal tubes with glass to metal end seals; epoxy filled metal tubes with epoxy end seals; or nonmetallic casings. The DL-130 illustrated has a delay time of 2 μsec, a rise time of 0.22 μsec, an impedance of 1,000 ohms and an insertion loss of 0.001 db max. It measures 3 in. long by 0.5 in. diameter. Price is $45.50.

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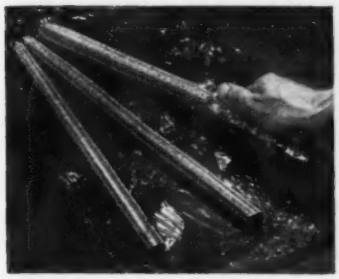


High Purity Silicon
POLYCRYSTALLINE ROD

DOW CORNING CORP., Midland, Mich., is producing high purity silicon in polycrystalline rod form. Above Grade I in quality, these rods are especially suitable for zone refining to the single crystal silicon used in power rectifiers, transistors, diodes, and other semiconductor devices. By vacuum zone refining, the rod can be converted to single crystal silicon having typical resistivity greater than 1,000 ohm-cm, minority carrier lifetime greater than 400 μsec. Company uses the Siemens-Westinghouse process of trichlorosilane decomposition for producing silicon. The rods are produced by a method that assures greater purity than casting. Available in various diameters up to 1 in. and lengths to 17½ in., these rods are characterized by a high degree of purity and maximum uniformity to facilitate zone refin-

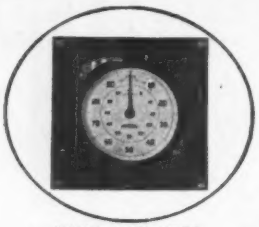
RELIABILITY

Air Force-Martin Mace B, 1200-mile inertial guidance tactical missile, incorporates the proven basic design of Matador and Mace A—operational missiles with outstanding records of years of reliable front-line service.

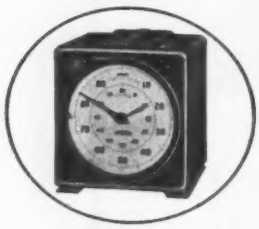
MARTIN

STANDARD TRADEMARK ...When there's

NO SUBSTITUTE for PRECISION TIMING



PANEL MOUNTED



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When the emphasis is on accuracy in timing, the wise choice is STANDARD precision elapsed time indicators. Units are synchronous motor driven . . . electric clutch controlled by manual or automatic switch or output of electronic tubes . . . available with manual or electric zero reset, a-c or d-c clutch.

Model	Scale Divisions	Totalizes	Accuracy
S-100	1/5 sec.	6000 sec.	±.1 sec.
S-60	1/5 sec.	60 min.	±.1 sec.
SM-60	1/100 min.	60 min.	±.002 min.
S-10	1/10 sec.	1000 sec.	±.02 sec.
S-6	1/1000 min.	10 min.	±.0002 min.
S-1	1/100 sec.	60 sec.	±.01 sec.
MST	1/1000 sec.	.360 sec.	±.001 sec.
MST-500	1/1000 sec.	30 sec.	±.002 sec.

Request Catalog No. 198

THE STANDARD ELECTRIC TIME COMPANY

89 LOGAN STREET, SPRINGFIELD, MASSACHUSETTS

CIRCLE 203 ON READER SERVICE CARD

TOROIDUCTORS

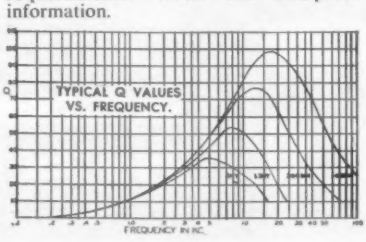
Standard Toroidal Inductors

Versatile Design for Wired Circuit and Printed Circuit Application

Forbes and Wagner TOROIDUCTORS are built to the highest standards of precision and quality. They are available in a wide range of Inductance Values from 3.3 MH to 33 H with DC Resistance and Distributed Capacity values to meet almost every application requirement.

The Type A cores provide an essentially linear change of inductance vs. temperature over a temperature range from −60°F. to +180°F. When used with a polystyrene capacitor for tuned circuit applications, an extremely low drift circuit results.

TOROIDUCTORS are also available in many other core materials to meet special requirements. Write for complete information.



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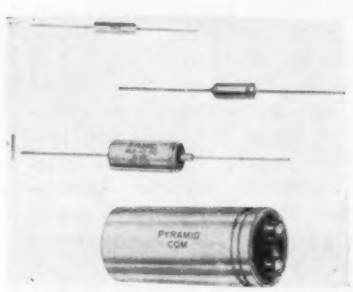
CIRCLE 328 ON READER SERVICE CARD

Noise Figure Meter

MONITORS RADAR SETS

HEWLETT-PACKARD CO., 1501 Page Mill Road, Palo Alto, Calif. Model 344AR directly and continuously monitors the noise figure of operating radar sets. It operates on either a 25 or 30 Mc i-f frequency, and is designed for direct application to pulse radars with repetition rates of 90 to 500 pps, or up to 3,000 pps with special sampling circuitry. The instrument's fast meter response enables the operator to optimize or adjust the radar system during operation or maintenance. With the compact and transistorized unit, system noise figure is measured on a time-shared basis with the radar scan. The 344AR's high sensitivity minimizes signal and transmitter losses; the noise source may be decoupled 20 db from the main transmitter lines. Two alarm functions give visible and electrical indication when an allowable noise figure is exceeded, or a noise source malfunctions.

CIRCLE 329 ON READER SERVICE CARD



Capacitors

HIGH RELIABILITY

PYRAMID ELECTRIC CO., Darlington, S. C. The MLE subminiature electrolytic is designed for operation in very critical circuits. Company

assures 10 years of service when operated within stated electrical specifications; temperature range −40 C to +85 C. The CQM electrolytic is made in high purity aluminum containers hermetically sealed. This capacitor is ideally suited for computer requirements, has a long life, low leakage current, is designed to operate at −20 C to +65 C. The TAK-H is a wet electrolyte tantalum capacitor of rugged construction, is seep and vibration proof, and is made to meet specifications MIL-C-3965. The TAD is a solid tantalum high reliability capacitor. Available in wide variety of sizes and values, it is hermetically sealed and has a long shelf and operating life; temperature range —40C to +85 C, 125 C with derating.

CIRCLE 330 ON READER SERVICE CARD

High Voltage Relay

MINIATURE SIZE

RESITRON LABORATORIES, INC., 2908 Nebraska Ave., Santa Monica, Calif. Minivac R-5 relay that will switch 3,000 v, is 2 in. long, ¾ in. in diameter and weighs 1 oz. Unit will handle up to 750 va with a maximum contact rating of 4 amperes. The contacts are sealed in high vacuum, assuring long life without degradation. This relay is designed to meet rugged environmental requirements including shock, vibration and temperature, and conforms to various MIL specs.

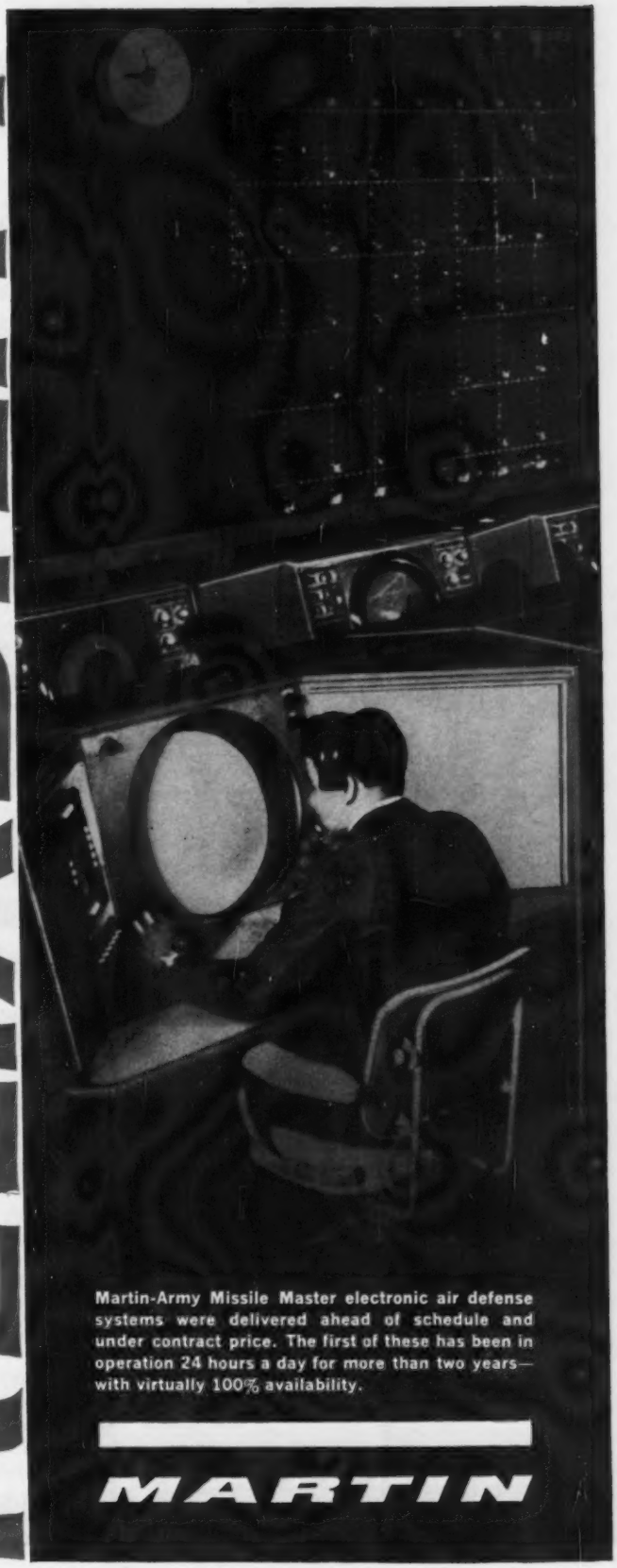
CIRCLE 331 ON READER SERVICE CARD

Digital Systems

RAPID ASSEMBLY

DYNAMIC CONTROLS CO., 2225 Massachusetts Ave., Cambridge 40, Mass. Rapid assembly and easy converti-

RELIABILITY



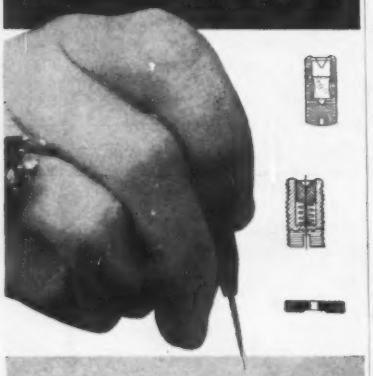
Martin-Army Missile Master electronic air defense systems were delivered ahead of schedule and under contract price. The first of these has been in operation 24 hours a day for more than two years—with virtually 100% availability.

MARTIN

Bird

JEWEL BEARINGS

TINY ENOUGH



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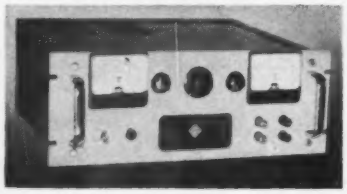
bility from an experimental to a permanent system are featured in the Digipac line of miniature logic blocks and chassis, including built-in power supplies. The male ends of the blocks are plugged into chassis-mounted connectors which provide power. Logic terminals at the female ends remain exposed for interconnection with patch cord. No soldering is required. To convert to a permanent system, lugged pins and soldered bus are substituted for patch cord. Should wiring changes be necessary, or a new system required, the lugged wiring can be unplugged and discarded. The three sizes of standard chassis hold 50, 100, and 200 blocks, and mount on a 3½ by 19 in. panel. Other features: in the new Digipac line are spare space for auxiliary equipment; system operation at speeds up to 1 Mc; input power operation between 60 and 140 v, 50-1,000 cps.

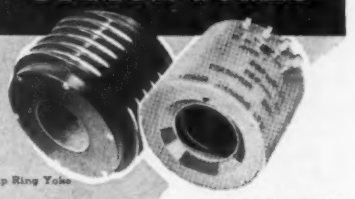
CIRCLE 332 ON READER SERVICE CARD



Power Supply
HIGHLY STABLE

MID-EASTERN ELECTRONICS, INC., 32 Commerce St., Springfield, N. J., has developed a new 100-v 3-ampere transistor power supply for requirements where extreme regulation and stability are paramount. Line regulation is 0.005 percent of maximum rated voltage and load regulation at 100 v does not exceed 0.01 percent. Unit features automatic overload protection and external load change sensing. Ripple is less than 500 μv rms. Recovery time at maximum rated current is less than 50 μsec and there is no overshoot when the power supply is turned on. Temperature compensation limits average drift to 0.02 percent per deg C and the supply may be operated continuously at full load at ambients up to 55 C, or at half load to 65 C. All components, including the power transistors, are

PRECISION DEFLECTION WITH COSSOR YOKES



Slip Ring Yoke

Two Axis Fixed Yoke

Component Development Engineering at its BEST!

- ADVANCED ELECTRICAL DESIGN
- PRECISION MECHANICAL DESIGN
- ACCURATE PRODUCTION METHODS

Custom Built to the most Exacting Specifications by Cossor Engineers

In Mumetal Cores for Optimum Geometry
In Ferrite Cores for Speed and Sensitivity
In Non-magnetic Cores for Perfection of Response

Any of Cossor's Three Core Types can be made in single or double axis with single or push-pull windings, and encapsulated for fixed or slip ring (rotating) use

Normal characteristics of yokes for 1 1 2 in neck tubes are

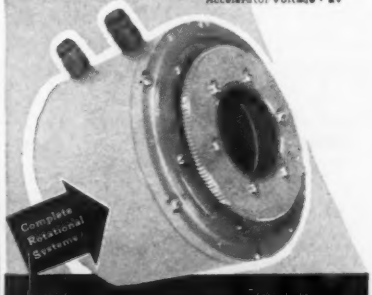
Positional accuracy — the spot position will conform to the yoke current co-ordinates within 0 25% of tube diameter For deflection angles less than ± 25° better accuracy can easily be achieved

Memory — 0 5% max without over swing 0 1% or less with controlled overswing

Complete encapsulation in epoxy (stycast) or silicone resins is standard for all Cossor deflection yokes, and is done with special moulding tools ensuring accurate alignment of the yoke axis When slip rings are added, solid silver rings are mounted in encapsulating resin. The finished slip ring yoke is precision turned to centre bore, and can include bearing mounting surfaces with dimensional tolerances approaching those associable with high quality metal parts.

Settling Time (Micro sec.) = $\frac{\text{Inductance in Henries}}{120 \sqrt{\text{Inductance in Henries}}}$

Sensitivity degrees/milliamperes = $\frac{\text{Inductance - millihenries}}{0.095 \sqrt{\text{Accelerator Voltage - kV}}}$



Complete Rotational Systems

COMPONENTS DIVISION

E.M.I COSSOR Electronics Limited

WOODSIDE, DARTMOUTH, N. S.
2005 Mackay St., Montreal, Que.
3077 Bathurst St., Toronto, Ont.
Corporation House, 160 Laurier West, Ottawa, Ont.

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derated for maximum reliability. Plug-in modules are standard for ease of replacement and maintenance. Price is $825.

CIRCLE 333 ON READER SERVICE CARD

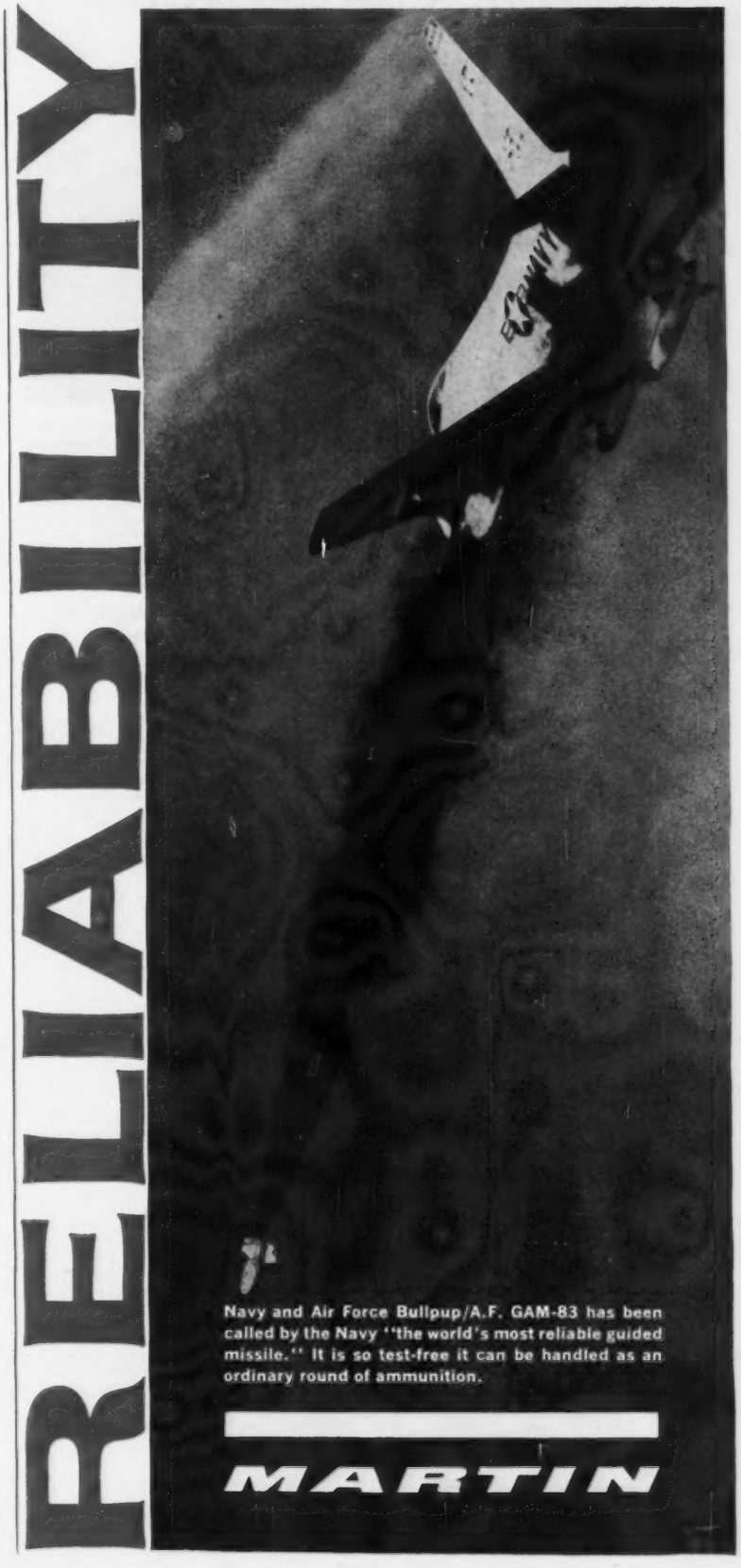
Infrared Detectors
INDIUM ANTIMONIDE

ITT LABORATORIES, 3700 E. Pontiac St., Fort Wayne, Ind., announces indium antimonide photoconductive infrared detectors sensitive in the intermediate infrared spectrum. The new detector cells have high sensitivity and fast response and are ideally suited for use with mechanical scanners for infrared mapping of terrain or for search and track of aircraft, missiles, tanks, etc. For cooling to its operating temperature of 77 deg Kelvin, the sensitive element is mounted on the end of a cooling well of unique design permitting the use of either liquid nitrogen or a cryostat for operation with pressurized nitrogen gas. A wide range of cell resistances permits efficient coupling to either transistor or vacuum tube preamplifiers. The detectivity of these new cells, measured at 77 deg Kelvin operating with a 500-deg Kelvin black-body radiation source, a 900-cps chopping frequency, and a 1-cps bandwidth, is in excess of 4×10^9.

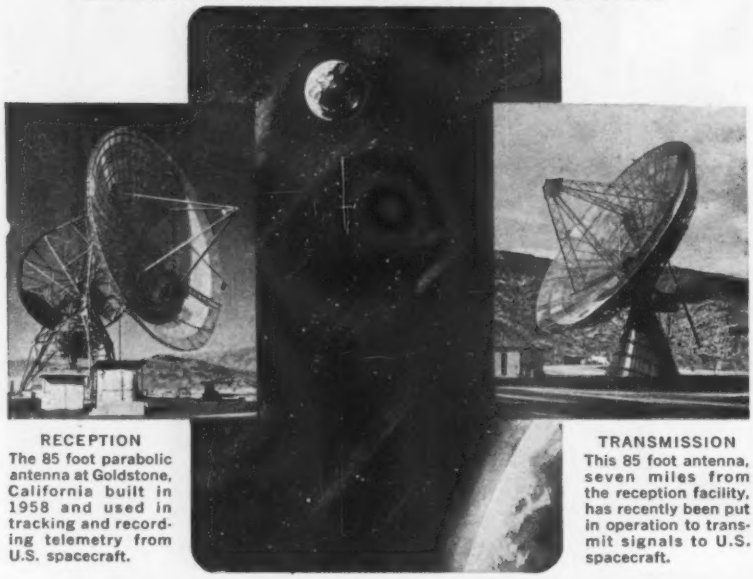
CIRCLE 334 ON READER SERVICE CARD

Microwave Equipment
GREATER GAIN RATIO

UNITED PRODUCTS, 165 Franklin Ave., Nutley, N. J. Microfilm attenuator materials can now be applied on microwave pistons and plungers. It can also be applied on the inner walls of cavities to pre-


RELIABILITY
Navy and Air Force Bullpup/A.F. GAM-83 has been called by the Navy "the world's most reliable guided missile." It is so test-free it can be handled as an ordinary round of ammunition.
MARTIN

LUNAR and PLANETARY COMMUNICATION



RECEPTION
The 85 foot parabolic antenna at Goldstone, California built in 1958 and used in tracking and recording telemetry from U.S. spacecraft.

TRANSMISSION
This 85 foot antenna, seven miles from the reception facility, has recently been put in operation to transmit signals to U.S. spacecraft.

SENIOR RESEARCH SPECIALISTS

New opportunities involving advanced research and development projects are now open at JPL in the Laboratory's Telecommunications Division for engineers and scientists capable of assuming a high level of technical responsibility.

SOME SPECIFIC OPENINGS IMMEDIATELY AVAILABLE

Communication Specialists
Execution of RF tracking and communication system projects.

Radio Research Engineers
Design of advanced RF transmitter/receiver equipment.

Antenna Specialists
Analysis, design and evaluation of giant Antenna Structures and Servo Systems.

Research Scientists
Digital data and control system analysis and synthesis.

Mathematicians or Communication System Analysts
Analog and Digital system analysis. Noise, coding, information theory. Linear and non-linear filter theory.

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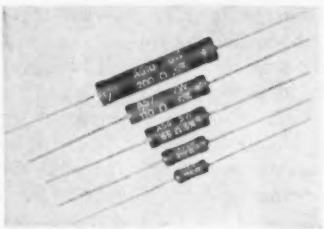
COMPONENTS

COMMUNICATION ACCESSORIES COMPANY
386 Lee's Summit, Missouri

vent leakage of energy—thus providing for greater gain ratio in microwave equipment. New process allows for films as thin as 0.004 in. to be applied on inner or outer walls. This technique now permits engineers wider tolerances between mating components in an assembly without sacrificing gain or providing for elaborate methods of overcoming stray leakage to prevent distortion. The compositions of the films permit use in the temperature range of −60 F to +300 F. Special formulations can be made to go to 500 C.

CIRCLE 335 ON READER SERVICE CARD



Wirewound Resistors
AXIAL LEAD

INTERNATIONAL RESISTANCE CO., 401 N. Broad St., Philadelphia 8, Pa., announces a new full line of axial lead power wire wound resistors having both commercial and military applications. Included are 2, 3, 5, 7 and 10 w units rated at 125 C ambient, each of which derate on a straight line from 125 C to 0 percent at 350 C. This "AS" line includes commercial 1 percent and 3 percent resistors and military 5 percent units for types RW 55 through RW59 which meet or exceed all characteristic "G" and "V" requirements of MIL-R-26-C.

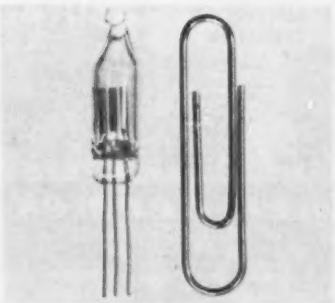
CIRCLE 336 ON READER SERVICE CARD

Holding Clip
FOR COMPONENTS

ATLEE CORP., 47 Prospect St., Woburn, Mass. Made of beryllium copper, the new clip insures posi-

tive holding power through an unusual design feature that permits both sides to work independently from each other. It will accommodate components up to 1 in. square, or 1 in. by 2 in. rectangular. Use of beryllium copper provides excellent heat dissipation, long life and reliability, with great resistance to fatigue. Components may be easily removed and replaced despite the strong spring tension. Holder is designed for mounting relays, capacitors, vibrators, transformers, condensers, and similar small components.

CIRCLE 337 ON READER SERVICE CARD



Trigger Tubes

FOUR NEW TYPES

SIGNALITE, INC., Neptune, N. J., has available four new miniature trigger tubes designed for high and low current applications. The design engineer will be able to select a tube for his particular circuit requirements. The LTG-27-2 and LTG-27-2A, 6.0 ma average current; the 120 TG-27-2 and 160 TG-27-2, 0.5 ma average current.

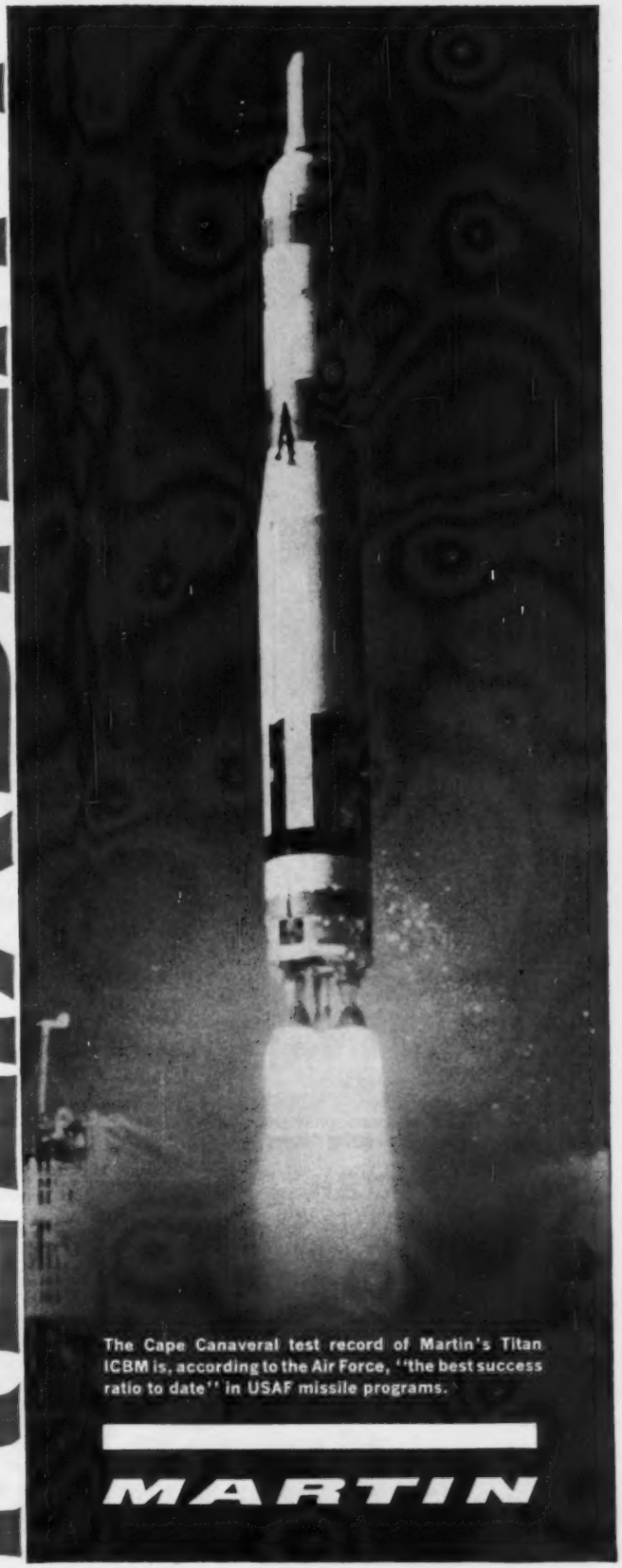
CIRCLE 338 ON READER SERVICE CARD

Tunnel Diodes

GALLIUM ARSENIDE

GENERAL ELECTRIC CO., Syracuse, N. Y., has introduced five new types of gallium arsenide tunnel diodes. Type 1N3114 has a peak point cur-

RELIABILITY



The Cape Canaveral test record of Martin's Titan ICBM is, according to the Air Force, "the best success ratio to date" in USAF missile programs.

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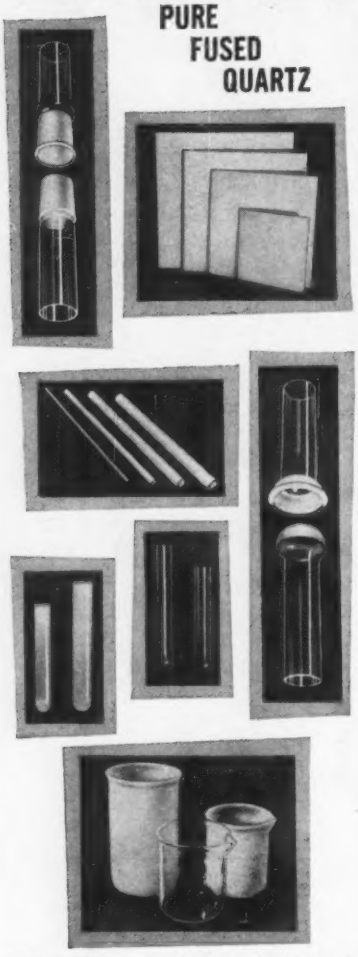

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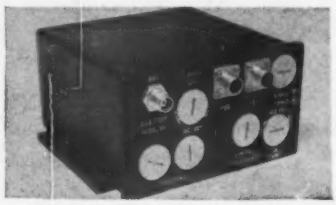
rent of 2.2 ma held to ± 10 percent; the 1N3115 also has a peak current of 2.2 ma but this is held to ± 2.5 percent; 1N3116, 4.7 ma., held to ± 10 percent; 1N3117, 4.7 ma, controlled to ± 2.5 percent; 1N3119, 10 ma, controlled to ± 2.5 percent. All have typical peak point current to valley point current ratios of 15 and voltage swings of 1.0 v. Typical switching speeds with constant current drive are 2.4 nanoseconds for the 2.2 ma units, 2.3 nsec for the 4.7 ma devices, 1.6 nsec for the 10 ma models.

CIRCLE 339 ON READER SERVICE CARD



Radar Transponder
TRANSISTORIZED

AERO GEO ASTRO CORP., 1200 Duke St., Alexandria, Va. The AGA C/T Mod 2 radar transponder is a transistorized unit for airborne applications compatible with present day instrumentation radars similar to AN/FPS-16 and AN/MPS-26. Its small size (92.6 cu in.), low weight (5.75 lb), plus its low power consumption and ability to operate in missile environment make it an ideal instrument for many varied purposes. The electrical characteristics represent superheterodyne sensitivity, single or double pulse interrogation, and a 400 w transmitter output. A solid state modulator is incorporated with recovery time on the order of 160 μsec.

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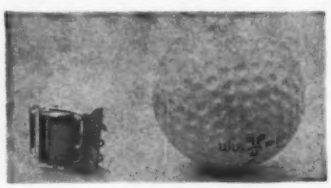

SPDT D-C Relay
HIGH SENSITIVITY

W. S. DEANS CO., 8512 E. Gardendale, Downey, Calif. High reliabil-

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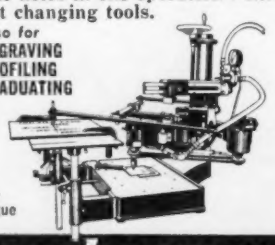

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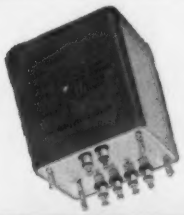
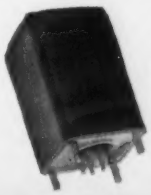
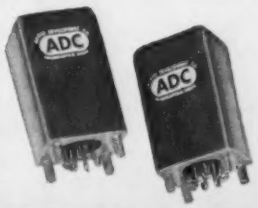


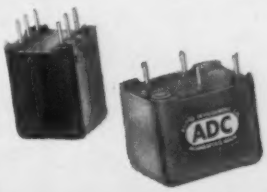
Military Standard POWER Transformers Types MS-90016 through MS-90036.



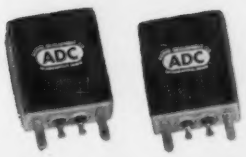
Military Standard AUDIO Transformers Types MS-90000 through MS-90008.



Sub-Miniature, hermetically sealed, low frequency inductors and transformers.



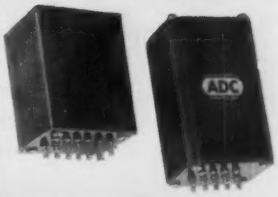
Transformers and filters for TRANSISTOR and PRINTED CIRCUIT applications to meet MIL-T-27A Grade 5, Class R or S.



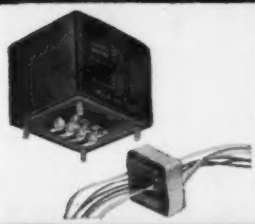
Toroids—Hermetically sealed or open units for all frequency ranges.

Filters—Sub-Audio to 1.5 mcs.

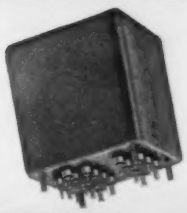
Telephone Coils—Mechanically and electrically interchangeable with Western Electric.



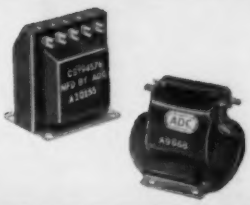
Broadcast Quality Transformers—Standard of the industry.



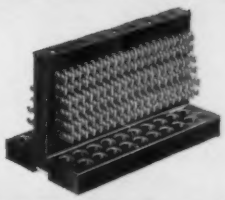
Magnetic Amplifiers and Saturable Transformers—For servo motor control; DC-DC Power Supplies, and switching silicon controlled rectifiers.



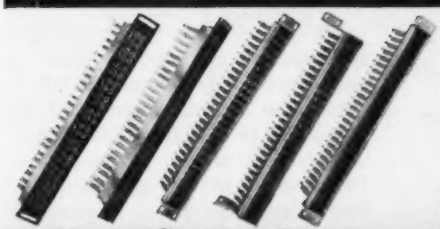
Balanced Modulators—Designs over a wide range up to 500 kcs.



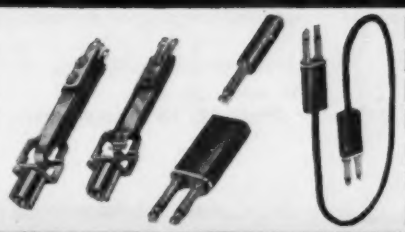
Encapsulated Transformers—Using custom epoxy compounds for military and commercial applications.



Terminal Blocks—Molded to your specifications. Six popular sizes in stock.



Jack Panels—Several size panels in stock.



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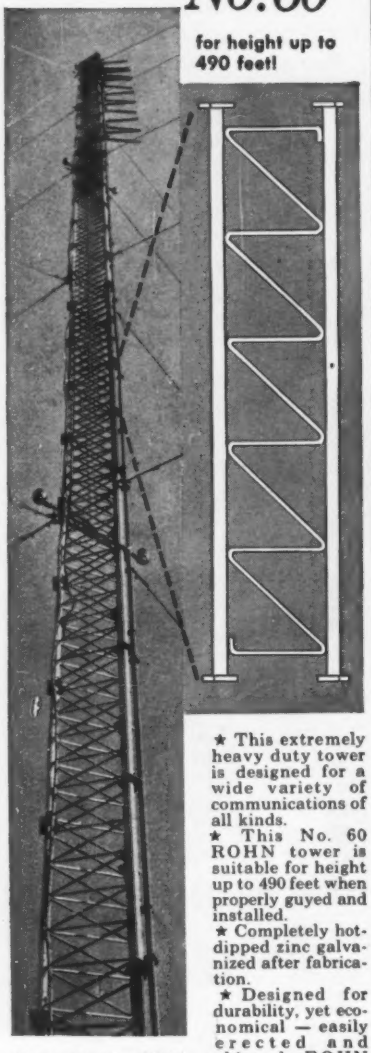
CIRCLE 113 ON READER SERVICE CARD 113

ROHN COMMUNICATION TOWER *No. 60*



for height up to 490 feet!

Shown above is a ROHN No. 60G tower used for FM broadcasting, installed to a height of 300 feet.

★ This extremely heavy duty tower is designed for a wide variety of communications of all kinds.
★ This No. 60 ROHN tower is suitable for height up to 490 feet when properly guyed and installed.
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ity, light weight, high sensitivity and small envelope are features of a new, low-cost subminiature spdt d-c relay which has been successfully cycled 508,500 times at 6 cps with no visible sign of wear or pitting; 150 v a-c at 250 ma was passed by contacts without arc suppression. Sensitivity: 35 mw. Dimensions: height, 0.687 in.; width 0.406 in.; length, 0.812 in. Other features: excellent contact wiping action; connections in single plane; single screw (2-56 x ¼) mounting. Units are available in 5,000 ohm, 1,250 ohm, 500 ohm, 100 ohm and 50 ohm coil resistances, or to user's specifications.

CIRCLE 341 ON READER SERVICE CARD

Test Jack
STAMPED LUG TERMINAL

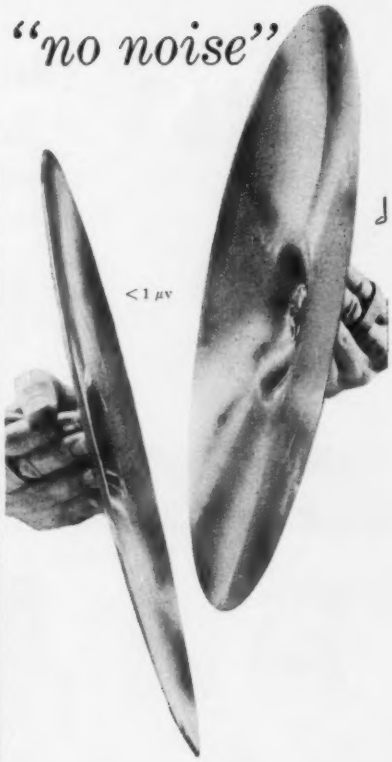
SEALECTRO CORP., 139 Hoyt St., Mamaroneck, N. Y. A "Press-Fit" test jack with a stamped lug on the reverse side of the chassis is now available. The SKT-36 utilizes the "Press-Fit" design for fast, permanent installation in a single hole. Unit is designed to receive a 0.050 in. diameter by 0.025 in. maximum probe. Beryllium copper contacts assure long service life, and minimum contact resistance. The stamped lug on the reverse side of the chassis is 0.287 in. long overall and provides a 0.052 in. by 0.156 in. soldering hole.

CIRCLE 342 ON READER SERVICE CARD

Power Supplies
TRANSISTORIZED

VALOR INSTRUMENTS, INC., 13214 Crenshaw Blvd., Gardena, Calif. New series of transistorized regu-

"no noise"



regulated... isolated... transistor

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Continuously variable output ranges in 6 standard models from 0 to 30 v and 0 to 200 milliamps at input of 117 v (95-135) 60 cps.

Noise level across a grounded 350 ohm bridge only 1.00 μv peak-to-peak typical. Line voltage regulation 0.03% and load regulation 0.03% no load to full load. Isolation 0.04 μμf of capacitive coupling to AC power line. Other specifications: also excellent. Immediate delivery with guaranteed performance.

Write today for our sales data sheet and name of nearest representative.

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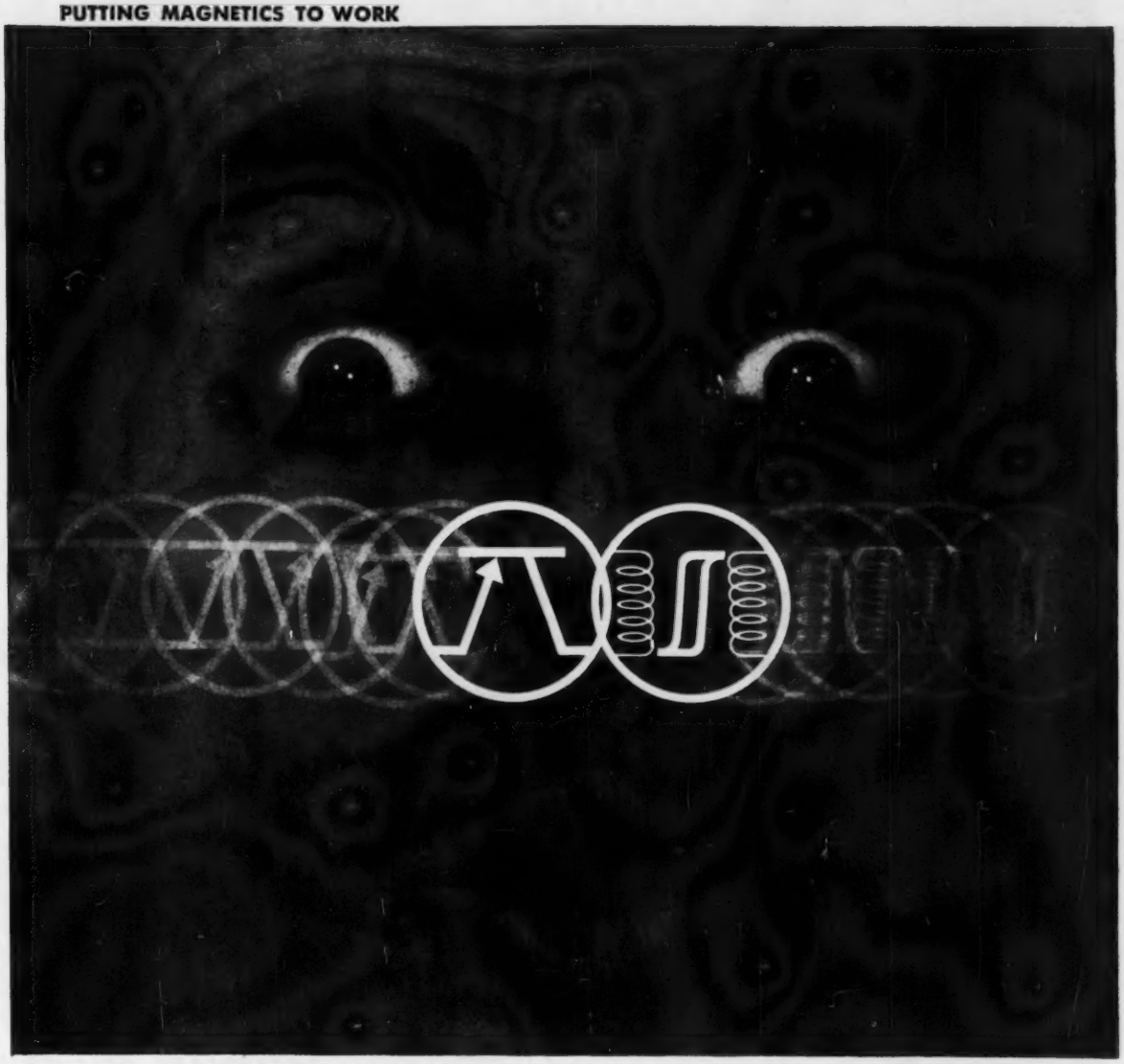

Open your eyes to new amplifier designs!

See how to combine tape wound cores and transistors for more versatile, lower-cost, smaller amplifiers

Tie tape wound cores and transistors into a magnetic-transistor amplifier, and open your eyes to new design opportunities.

To start with, these are static control elements—no moving parts, nothing to wear or burn out. Next thing you find is that you reduce components' size—your amplifier is smaller and costs less. That's because between them the core and the transistor perform just about every circuit function . . . and then some.

For instance? The core has multiple isolated windings. Thus you can feed many inputs to control the amplifier. The core also has a square hysteresis loop, and thus acts as a low loss transformer. That means you save power. In addition, the core can store and remember signals—so time delay becomes simple.

There's no need for temperature stabilization, either. The transistor acts only as a low loss, fast, static switch—and in this function it has no peer.

How do you want to use this superb combination? As a switching amplifier—or a linear one? In an oscillator? A power converter (d-c to d-c or d-c to a-c)? You'll have ideas of your own—and if they involve tape wound cores, why not write us? Ours are Performance-Guaranteed. *Magnetics Inc., Dept. E-81, Butler, Pennsylvania.*

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CIRCLE 115 ON READER SERVICE CARD 115

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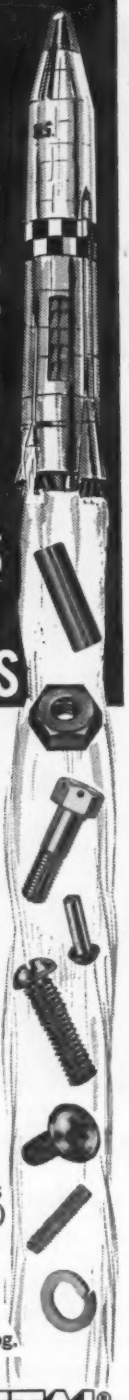

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5822 West Washington Blvd., Culver City, Calif.
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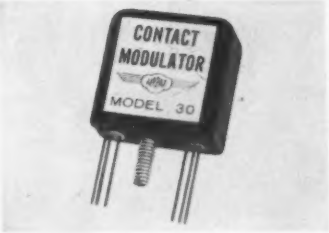
lated power supplies features an excellent transient response, high stability and very low weight. Typical of the series is model PS111M with the following specifications: output 12 v d-c, 0-5 amperes; transient response 50 mv or less for 50 μsec or less under square wave load conditions; no line transients; line regulation 0.1 percent; load regulation 0.25 percent; output impedance 0.01 ohm d-c to 5 Kc; stability 0.5 percent or 50 mv for 24 hours after warm-up; ripple 1 mv rms; size 19 in. by 5¼ in. by 10 in.; weight 15 lb; input 105-125 v, 60-400 cps. Price is $395; other models at lower prices.

CIRCLE 343 ON READER SERVICE CARD



Low-Noise Chopper
EXTREMELY SMALL

AIRPAX ELECTRONICS INC., Cambridge Division, Cambridge, Md. Weighing but 9 grams, the diminutive, electromechanical model 30 chopper introduces a completely new operating principle. The chopper is tailored for printed circuit use and employs ruggedized jewel bearings. Characteristics: drive, 6.3 v at 60 cps; dwell, 175 deg average; phase, 25± 10 deg; balance, within 15 deg. Delivery is 2 to 6 weeks.

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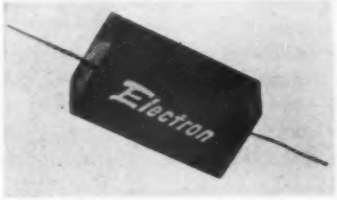

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ALPHA electronic WIRE

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For all these benefits, Alphlex Zipper Tubing is used by such OEM leaders as IBM, IT&T, Librascope, Lockheed, Martin, Sperry Rand and Government agencies. Write for free Alphlex Catalog Z-2.

The new Alphlex Closing Tool (above) designed to save you time, labor and money in your cable production requirements is free with each order of 1,000 feet of Zipper Tubing.

TYPES OF ZIPPER TUBING	
ZIP-31	fabricated from .020" polyvinyl sheet made from MIL-I-631C materials. All purpose type for general applications to 105°C. Standard colors: Clear, Black, Yellow.
ZIP-31M	heavy duty construction. Similar to ZIP-31 type except nominal wall thickness of .040". Standard colors: Clear, Black.
ZIP-44	polyvinyl sheet made from MIL-I-7444B materials. Extremely flexible; for aircraft and low-temperature uses to –67°C. Standard colors: Clear (amber), Black.
ZIP-44M	heavy duty construction. Similar to ZIP-44 type except nominal wall thickness of .040". Standard colors: Clear (amber), Black.
ZIP-50	"sandwich" of aluminum foil laminated between two sheets of polyvinyl. For 100% RF shielding applications to 105°C. Standard color: Silver Grey.
ZIP-90	polyvinyl bonded to woven fibreglass sheet per MIL-I-3190A. For rough usage, abrasion resistance, and high temperature uses to 130°C. Standard color: Black.
	All types available in inside diameters from ¼" to 2" in increments of ⅛"; and from 2" to 4" in increments of ¼". Alphlex Zipper Tubing covered by Patents #RE24,613 and #2,558,367 and other patents.

ZIPPER SPECIFICATIONS FOR ALL TYPES OF ALPHLEX ZIPPER TUBING	
Material	Polyvinyl Chloride
Track Thickness (when closed)	.095"
Dielectric Strength, V/mil	750
Tensile Strength P.S.I.	3810
Ultimate Elongation	255%
Operating Temperature, Upper Limit	105°C
Cold Brittleness	–80°C
Fungus-proof	will not support fungus
Flammability	self-extinguishing
Lateral Pull Strength (unsealed)	42.7 pounds/inch
Lateral Pull Strength (permanently sealed)	50.8 pounds/inch
Standard Colors	Black, Clear, Yellow

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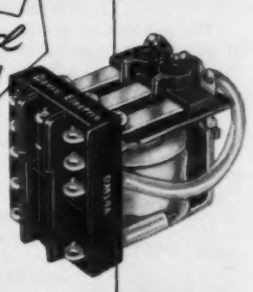
.5 to 250 VAC or .2 to 130 VDC.

CONTACTS
1 to 3 poles, single or double throw—5 or 10 amp.

MOUNTING
6-32 stud, 6-32 tapped hole, or octal plug.

DIMENSIONS
1" wide x 1-9/32" high x 1-13/16" long.



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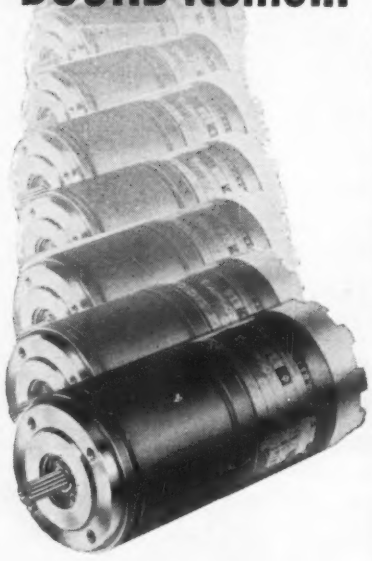

and in production quantities!

Mark 7 Mod 0	Size 15 Servo Motor
Mark 7 Mod 1	Size 15 Servo Motor
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The addition of our second factory means delivery in six to twelve weeks on many other G-M Servo Motors and Motor Generators as well; sizes 8 to 18, including other BuOrd items.

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ME subminiature metallized paper capacitors, designed for use in d-c circuitry, are vacuum epoxy-impregnated and sealed in epoxy cases. Operating temperature is −55 to +125 C. Capacitance values are from 0.001 to 2.0 μf. Series WE, for use in a-c or d-c circuits, are vacuum wax-impregnated and have an operating temperature range of −55 to +85 C. Capacitance values are from 0.001 to 1.5 μf. Both series are available in 100, 200, 400 and 600 vdcw ratings. Standard tolerance is ±20 percent with tighter tolerances to order. These metallized paper capacitors sealed in epoxy tubes meet or exceed most military environmental specifications.

CIRCLE 345 ON READER SERVICE CARD

H-V Pulse Tube

FORCED AIR COOLED

NUCLEAR CORP. OF AMERICA, Central Electronics Manufacturers division, 2 Richwood Place, Denville, N. J. Specifically designed for pulse operation, the XD-5 forced air cooled triode will switch 30 amperes at 40,000 v with a duty of 0.030. This results in a peak power output of 1.2 megawatts. Maximum ratings are: anode voltage, 35 Kv; grid voltage, −5,000 v d-c; grid current, 0.150 ampere; pulse width, 90 μsec; peak anode current, 30 amperes; peak cathode current, 45 amperes; peak anode voltage, 40 Kv.

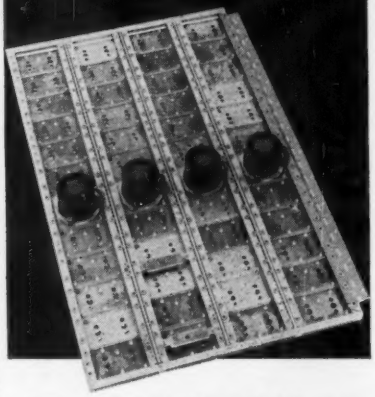
CIRCLE 346 ON READER SERVICE CARD

Log Amplifier

FOR FILTER ALIGNING

JERROLD ELECTRONICS CORP., 15th and Lehigh Ave., Philadelphia 32,

Environmental conditioning *for detection systems*



AiResearch cooling of airborne detection systems is accomplished by an extremely reliable, compact unit which is both an air-cooled cold plate and mounting structure for the detection system's transistorized power supply.

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AiResearch is the leading designer and manufacturer of such advanced electronic conditioning equipment and systems. This production unit is one example of the broad production-proven capability of AiResearch in providing extremely reliable, lightweight, compact cooling packages for aircraft, missile, space and ground support applications.

Environmental conditioning equipment has been produced for the following electronic systems: **Detection • Communication • Control • Ground Support • Guidance**

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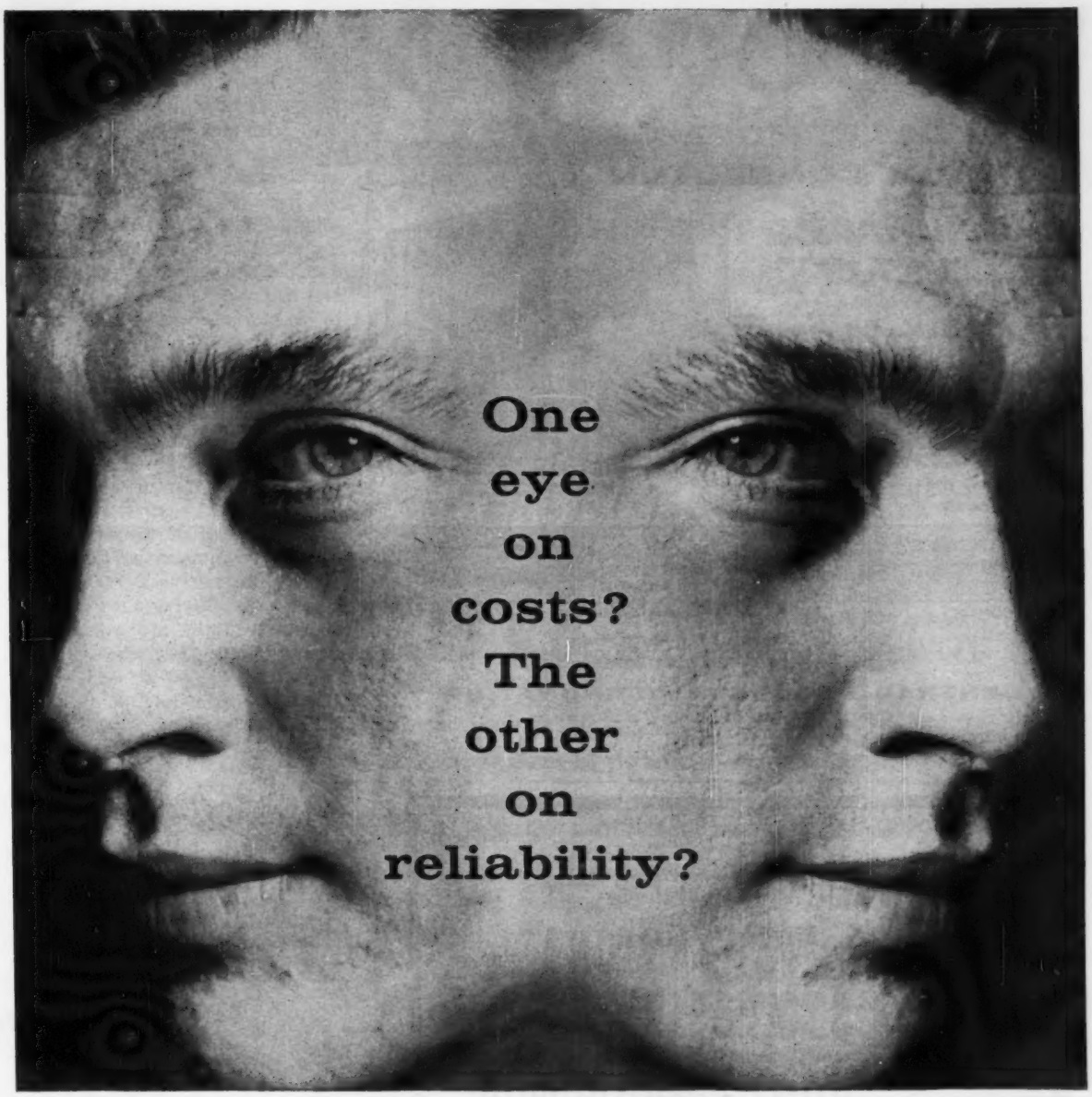
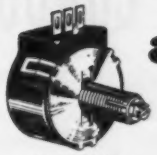
AiResearch Manufacturing Division

Los Angeles 45, California



Now! A sealed pot commercial at a regular pot price!



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Dust! Corrosion! Moisture! Fumes! All are foes of commercial and industrial equipment, yet ordinarily costly to keep out. Now, however, Waters introduces a new ¾" plastic case pot — the PT ¾ — with sealed pot reliability at a price no higher than many regular commercial pots! Even meets tough military specs (MIL-R-19A, MIL-R-19/1A)! "O" ring shaft seal and complete internal sealing virtually eliminate environmental problems. Provides the same protection as encapsulation in less space. Resistance range (ohms), ±5%, 1 to 20,000. Electrical and functional rotation, 355° without stops; 300° with stops. Dissipates 1.5W at 40°C. Torque, .3 to 6 oz./in. Weight, .02 lbs. Available with split or plain bushings, ¼" or ⅜" in diameter. Write for Bulletin PT 760.

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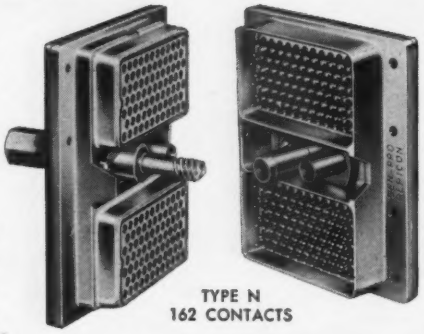

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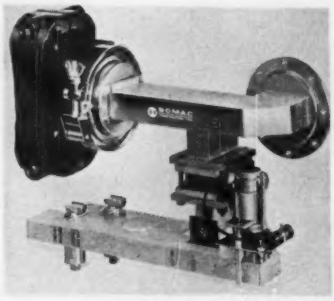
Pa. Model LA-* logarithmic amplifier makes 70 db dynamic sweep frequency filter measurements possible with standard oscilloscopes or X-Y plotters. It is especially useful in aligning crystal and other types of high attenuation filters. In aligning filters, the ability of the log amplifier to display a wide dynamic range permits the production test engineer or research specialist to observe all changes taking place in an overall response. It also eliminates the former "touch-and-go" method of filter alignment which was made necessary because only a small area of the total response could be viewed at any one time. An important new feature is a "log-expand" control which permits expansion of the first 10 db of the presentation so that accurate 3 db measurements can be made while viewing the entire 70 db range. Units are available in single octave frequency ranges from 2 Mc to 100 Mc and overall gain is approximately 100 db. Price with power supply is $500.

CIRCLE 347 ON READER SERVICE CARD



Microwave Assemblies
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BOMAC LABORATORIES, INC., Salem Road, Beverly, Mass., announces pre-packaged, pre-tested microwave assemblies, complete with components and associated hardware, ready for installation in the customer's radar unit. Typical is the assembly illustrated—a "package" consisting of a branch guide duplexer and a balanced mixer, with magnetron, tunable TR tube, klystron and crystals. Company engineers will design on order the modulator for this typical unit or other r-f package to supply negative pulses for the magnetron, either as

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INSIDE FRONT COVER — INSIDE BACK COVER

1	21	41	61	81	101	121	141	161	181	201	221	241	261	281	301	321	341	353	365
2	22	42	62	82	102	122	142	162	182	202	222	242	262	282	302	322	342	354	366
3	23	43	63	83	103	123	143	163	183	203	223	243	263	283	303	323	343	355	367
4	24	44	64	84	104	124	144	164	184	204	224	244	264	284	304	324	344	356	368
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6	26	46	66	86	106	126	146	166	186	206	226	246	266	286	306	326	346	358	370
7	27	47	67	87	107	127	147	167	187	207	227	247	267	287	307	327	347	359	371
8	28	48	68	88	108	128	148	168	188	208	228	248	268	288	308	328	348	360	372
9	29	49	69	89	109	129	149	169	189	209	229	249	269	289	309	329	349	361	373
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17	37	57	77	97	117	137	157	177	197	217	237	257	277	297	317	337			
18	38	58	78	98	118	138	158	178	198	218	238	258	278	298	318	338			
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299	319	339			
20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340			

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Employment Section

377	380	383	386	389	392	395	398
378	381	384	387	390	393	396	399
379	382	385	388	391	394	397	400

Searchlight Section

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461	464	467	470	473	476	479
462	465	468	471	474	477	480

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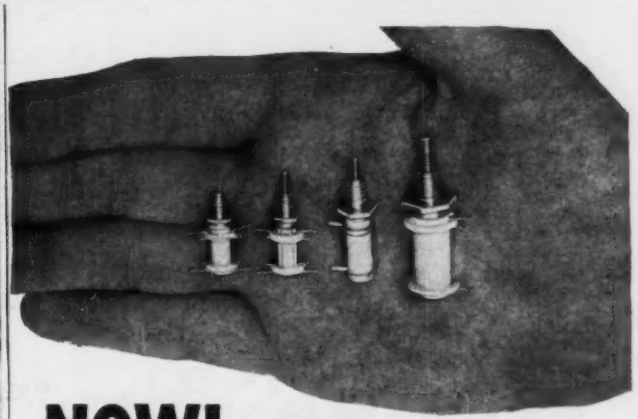

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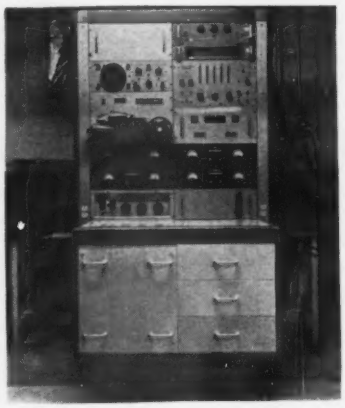

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ORTRONIX, INC., P. O. Drawer 8217, Orlando, Fla. Automatic dynamic testing of component subassemblies or complete system checkout can be accomplished economically by the ADEPT "400". Complete flexibility of testing is obtained by control of 295 signal, power and test control lines with punch tape programming.

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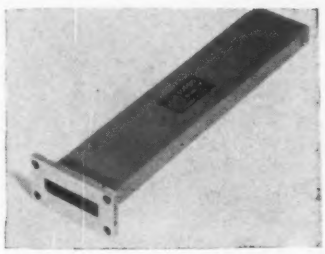

Broadband Termination
HALF-X TYPE

TURBO MACHINE CO., Lansdale, Pa., announces a broadband termination for 0.900 by 0.200 in. i-d waveguide. This absorbing load exhibits a vswr of less than 1.03:1 from 8,200 to 12,400 Mc. Maximum power dissipation is 1 w average making the termination suitable for most low power design measurements and production testing. Measuring 6 in. in length, cast aluminum construction results in a rugged yet light device. Flanging consists of a centered UG-67/U configuration.

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Fit curved surfaces
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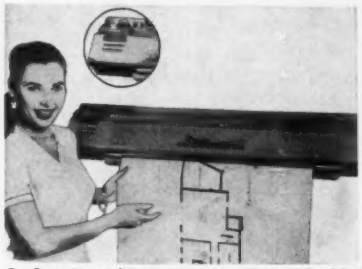
Rotolite Announces "Dial-control" Whiteprinter for Electronic Engineers

Electronic engineers save money by making their own whiteprints with the new Rotolite White printer. It has finger-tip controls and employs the fastest white printing lamp on the market. The new model is known as the Rotolite "Expeediter."



In keeping with company policy, this high quality diazo whiteprinter is the lowest priced of all makes. Its single new lamp gives it simplicity and the lowest up-keep cost. Both the printing unit and the transparent developing tube can be mounted on any office wall. It is easy for anyone to operate. There are no messy chemicals or trays to fool with, as it provides dry copies of anything printed, written or drawn on translucent material at the lowest copying cost possible: one cent for letter size or one and a half cents per square foot. Five models of Rotolite are available, taking any length paper in widths of 18, 27 and 42 inches. Prices start at $129.50.

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RADIO INTERFERENCE CONTROL Genistron, Inc., 6320 Arizona Circle, Los Angeles, Calif. "Radio Interference Control of Semiconductor Circuitry", a recently presented technical paper, is now available as a 32-page booklet.
CIRCLE 351 ON READER SERVICE CARD

SYNCHRO MOUNTING INSTRUCTIONS Muirhead & Co. Ltd., Beckenham, Kent, England, has available a new leaflet giving comprehensive details and illustrations on mounting and zeroing all types of synchros and servomotors, fixing gears or pinions.
CIRCLE 352 ON READER SERVICE CARD

MICROWAVE PRESSURE WINDOWS Microwave Associates, Inc., Burlington, Mass., has available a new 12-page brochure describing waveguide pressure windows, their applications and installation suggestions.
CIRCLE 353 ON READER SERVICE CARD

CRYSTAL CASE RELAY Union Switch & Signal, division of Westinghouse Air Brake Co., Pittsburgh 18, Pa. Bulletin No. 1064 is a four-page brochure describing a new 2-pole, double throw general purpose crystal case relay.
CIRCLE 354 ON READER SERVICE CARD

SEMICONDUCTOR MATERIAL Chimel S. A., 11 Rue General-Dufour, Geneva, Switzerland. Bulletin 7760 lists some properties, specifications and applications of gallium arsenide, a semiconducting compound analogous to germanium and silicon.
CIRCLE 355 ON READER SERVICE CARD

SWITCH CATALOG Control Switch Division, Controls Co. of America, Folcroft, Pa. Catalog 130 features hermetically-sealed and environment free switches, complete with details on variation, engineering drawings and specs.
CIRCLE 356 ON READER SERVICE CARD

LAMINATED PLASTICS Formica Corp., 4550 Spring Grove Ave., Cincinnati, O. Copies of the 1961 edition of Formica Designer's Fact Book, a technical reference book on laminated plastics, are

the Week

available free to research and production engineers, designers and purchasing agents. Send name and title on company letterhead.

T-W TUBES Huggins Laboratories, 999 East Arques Ave., Sunnyvale, Calif. A new two-color short form catalog lists a line of over 85 basic traveling-wave tube types covering the vhf through Ku-bands, along with pertinent tube characteristics, prices, delivery quotations, and local sales representatives.

CIRCLE 357 ON READER SERVICE CARD

PULSE WAVEFORM GENERATOR Parabam, Inc., 13000 Yukon Ave., Hawthorne, Calif. Technical information concerning the new model P-1 pulse waveform generator is now available in the company's Technical Bulletin No. 660-6.

CIRCLE 358 ON READER SERVICE CARD

ANGULAR ACCELEROMETERS Donner Scientific Co., Concord, Calif. Features, applications and specifications of a line of angular servo accelerometers are included in a new six-page brochure now available.

CIRCLE 359 ON READER SERVICE CARD

RADIO TELEPRINTER RECEIVING TERMINALS Racal Engineering Ltd., Western Road, Bracknell, Berkshire, England. Technical publication No. 172C1 covers types RA.103 and RA.129 continuously tuned frequency shift radio teleprinter receiving terminals.

CIRCLE 360 ON READER SERVICE CARD

HIGH SPEED COMPUTATION Applied Development Corp., 12838 Weber Way, Hawthorne, Calif. A four-page folder covers the Uni-Bloc model 3-303 computing unit, an important member of the company's line of modular data-processing equipment.

CIRCLE 361 ON READER SERVICE CARD

TOROIDAL COMPONENTS Johnson Electronics, Inc., P.O. Box 1675, Casselberry, Fla. A new 8-page technical data brochure describes a line of subminiature toroids and standard toroidal coils.

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C 11	6.3	173	.36"
C 2	6.3	171	.44"
C 22	5.5	184	.44"
C 3	5.4	197	.64"
C 33	4.8	220	.64"
C 4	4.6	229	1.03"
C 44	4.1	252	1.03"

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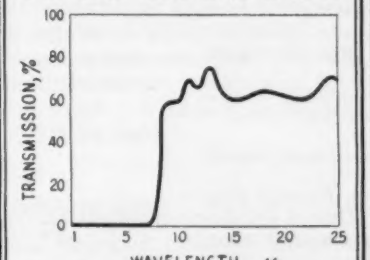

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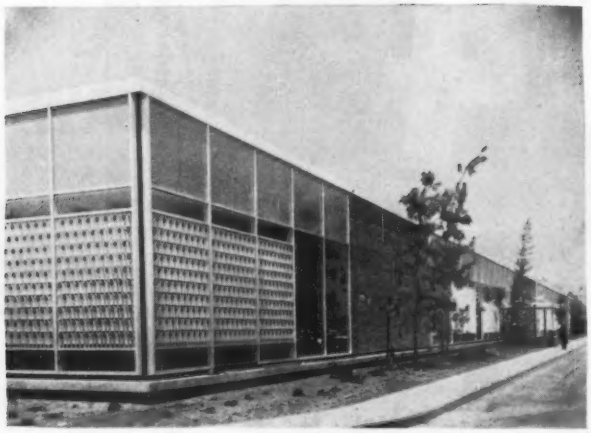


Litton Opens New Laboratory

LITTON SYSTEMS, INC., recently opened its 180,000-sq-ft Computer Systems Laboratory to conduct advanced electronics development and production operations on a 63-acre site in Woodland Hills, Calif.

Inside the new air-conditioned building is carried on the development and production of compact, high-speed and versatile computers for navigation and fire control of missiles or aircraft. A portion of the building also is used for production of inertial guidance systems.

Among the computer systems in various stages of development or production are a bombing-navigation system for the Grumman A-2F, a tactical computer for the Eagle missile, a ballistics computer for field use by the U. S. Marine Corps, central air data computers and celestial-inertial navigation computers. Some of the computers are used to accomplish necessary fire control, engine control, cruise control and navigation functions in an aircraft.

The new building is the first of several to be built by Litton on the site. Manufacturing buildings, offices and other structures eventually will comprise a complex with a 750,000 sq ft area.

Harrahill Assumes New Position

JOSEPH R. HARRAHILL has been selected as vice president and general manager of Hermetic Seal Transformer Co., Garland, Texas. One of the Dresser industries, this company produces magnetic iron-core components, power supplies, servo amplifiers, and other electronic products.

Harrahill comes to Hermetic Seal Transformer from Dresser Manufacturing Division, Bradford, Pa., where for the past five years he has been vice president in charge of manufacturing and product development. Earlier he was manager of manufacturing for Permutit Co. of New York City.

In his new post, Harrahill will guide the over-all planning and manufacturing programs for the entire HST operation which includes the firm's two components manufacturing plants in Garland, Texas, and Northridge, Calif.; the special products division in Dallas, Texas; and the environment test division in Garland.

Coulter Awarded John Scott Medal

WALLACE H. COULTER has been awarded the John Scott Medal by the city of Philadelphia for his invention of an electronic blood cell counter. The John Scott Medal, first awarded in 1810 to Benjamin Franklin, is administered by the city of Philadelphia. It is awarded yearly for outstanding inventions benefiting humanity.

Coulter's invention of the blood cell counter, now manufactured by Coulter Electronics Corp. of Chicago and Coulter Electronics Ltd. of London, is the result of his research and development work since 1945.

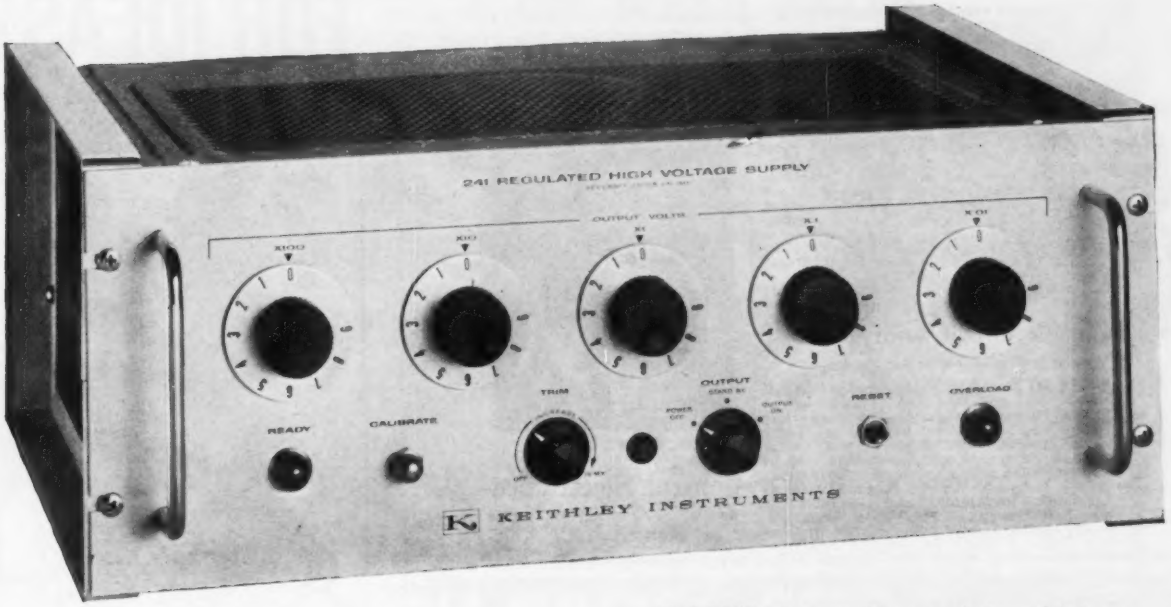
Machlett Laboratories Elevates Kirka

CHESTER KIRKA has been promoted to chief engineer of the x-ray tube section of The Machlett Laboratories, Inc., Springdale, Conn. Since 1958 he had been responsible for Machlett x-ray and electron tube sales and applications engineering activities throughout the eastern states.

In his new post Kirka will have responsibility for the research, development and product engineering supporting Machlett's line of x-ray tubes. Machlett has been a pioneer in x-ray tubes since 1897, just two years after Roentgen discovered x-rays.

Prior to his appointment in 1958

new photo-chopper-stabilized high voltage supply



Model 241 – incorporating new photo-modulator – offers high accuracy, stability, long service life. 2411 End Frames shown adapt unit to bench use.

Model 241 offers 0.05% accuracy, five-dial resolution from 0-1000 volts.

Here is the successor to dc secondary standards that employ mechanical choppers and standard cells. The new Keithley 241 offers freedom from adjustment and calibration, long term stability to voltage or temperature variations, and immunity to shock and vibration. Complementing the popular Keithley 240 supply, it offers greater accuracy, regulation, current output and floating operation.

High output accuracy, within 0.05%, is assured through the use of encapsulated wire-wound resistors with 0.02% divider accuracy.

Extreme stability of 0.005% per hour is assured by a highly stable, shockproof zenor diode, wire-wound standards in critical positions, and a highly stable, long life photo modulator which is immune to shock and vibration.

Other features include a position which removes voltage from the output, making possible connections while the instrument is operating; bench or rack operation.

BRIEF SPECIFICATIONS

Output Voltage: 0-1000 volts, plus, minus or floating. 100, 10, 1, 0.1, 0.01 volt steps; 5 calibrated panel switches. "TRIM" potentiometer permits interpolation between steps, with a resolution of better than 100 microvolts.

Output Current: Zero to 20 milliamperes.

Output Accuracy: Within 0.05% above 2 volts, within 1 millivolt below 2 volts.

Output Impedance: Less than 0.05 ohm at d.c.

Line Regulation: 0.005% or 1 mv for 10% line change.

Load Regulation: Better than 0.005%, no load to full load.

Ripple and Noise: Less than 1 millivolt RMS.

Stability: .005% per hour with constant load, line and ambient temperature.

Recovery Time: No load to full load, less than 1 second to rated accuracy.

Overload Protection: Relay disconnects output within 50 milliseconds when output current exceeds about 24 ma.

Price: Model 241 ..... $775.00

For complete details, write:

KEITHLEY INSTRUMENTS. INC.
12415 EUCLID AVENUE CLEVELAND 6, OHIO

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BOOK NEWS

National Association of Broadcasters

NAB Engineering Handbook

Just Out—5th Ed. Provides vital facts and best practices for handling virtually any job in broadcast engineering faster and more effectively. Brought to you by a staff of 47 noted authorities, this enlarged and updated Fifth Edition gives thousands of recommended practices as well as fundamentals, standards, and how-to working instructions on every phase of radio and TV engineering. Ranges from antennas and towers, transmitters, and program transmission, to studio facilities, color TV, remote pickups, and more. **Editor-in-Chief, A. Prose Walker; assisted by G. Bartlett, both of NAB. 5th Ed. 1728 pp., 1306 illus., $27.50**

Electronic Circuit Analysis

Volume I: Passive Networks

Just Out. Here are clear explanations of the theory, analysis, and applications of passive networks—basic guidance that equips you to more quickly and efficiently solve problems in designing and maintaining electronic equipment. Covered in full are such areas as a-c, d-c, transient, pulse forming, wave shaping, transformer equivalent, and inductively coupled circuits. The book explains mathematical procedures, shows how to apply the concept of graphic analysis, describes how to obtain graphic solutions using load line techniques, and more. **By P. Cutler, Antonetics Div.; assisted by H. Hoover, Atomics Interntl. Div., both of North American Aviation. 452 pp., 412 illus., $8.00**

Digital Computing Systems

Full coverage of digital computing systems: principles, design, operation, and applications. Describes the elements in modern computers, explaining underlying principles of the devices used and illustrating the devices themselves. The circuitry by which the elements perform desired functions is clearly covered, with examples of typical circuits. Logical design and programming are discussed, and how computers solve scientific, business, and data handling problems is shown. **By S. B. Williams, Consultant Dept. of Defense. 231 pp., 168 illus., $7.75**

Ultrasonics

Just Out—2nd Ed. A practical guide to essential theory, methods of generating waves, circuits, and the design of ultrasonic systems. Describes every important engineering phase—from the design consideration of ultrasonic crystals to the experimental measurement of ultrasonic waves. Revised, and updated, the Second Edition covers new developments in testing of materials, and in cleaning, welding, soldering, and other applications. **By B. Carlin, Circo Ultrasonic Corp., 2nd Ed. 350 pp., 263 illus., $11.50**

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to the applications engineering post, Kirka served for two years as a product engineer. He joined Machlett, a subsidiary of Raytheon Co., in 1952 as a design engineer. Earlier, he had been a field engineer with RCA.

Control Electronics Names Bliss G-M

WALDREN E. BLISS has been appointed general manager at Control Electronics Co., Inc., Huntington Station, N. Y.

Former vice president in charge of operations at Harvey-Wells Electronics, Southbridge, Mass., Bliss will be responsible for the internal coordination of overall operation at CEC. In addition to coordinating the functions of the production and service departments, he will also supervise the planning, scheduling and budget control for all the engineering departments.

Control Electronics manufactures a line of delay lines, filters and microwave components.

GE Appoints Statt Plant Manager

CYRIL J. STATT, a veteran of 20 years in the electronics operations of General Electric, has been named manager of the Schenectady

DIGGING FOR IDEAS?

If you're buying electronic equipment and components the best place to look is where the selection is the largest. Maybe there's a product or service you don't know about that will *solve* your problem.

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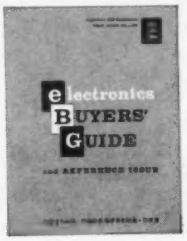

FIND WHAT YOU NEED IN THE **electronics BUYERS' GUIDE**

tube plant. He succeeds D. C. Scott who earlier was appointed manager of the company's cathode ray tube department in Syracuse, N. Y.

Prior to his new assignment, Statt was manager of manufacturing engineering and facilities for the company's Light Military Electronics department in Utica, N. Y.

Hoffman Board Elects David R. Hull

THE BOARD of directors of Hoffman Electronics Corp., Los Angeles, Calif., has elected David R. Hull corporate executive vice president.

In his newly-created position, Hull will initially have direct responsibility for the operation of Hoffman's Military Products division and coordination of activities of the company's Santa Barbara, Calif., Science Center with other corporate divisions.

Prior to his new position, he was for 10 years vice president and general manager of equipment operation for Raytheon Co.

During the period 1958 to 1960, Hull served two terms as president of the Electronic Industries Association and received the 1960 EIA medal of honor.

Rheem Semiconductor Hires Michael Mejac

MICHAEL MEJAC, chemical engineer, has been appointed to the research and development department of Rheem Semiconductor Corp., Mountain View, Calif., and has been assigned to device development projects.

Previously, Mejac was in the research department of Allen Bradley Co., Milwaukee, Wisc., studying properties of ferrites.

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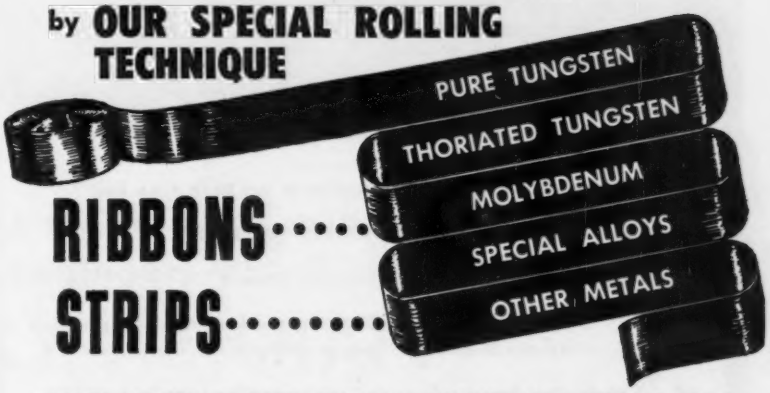

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missile tracking
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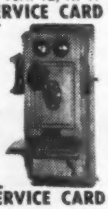

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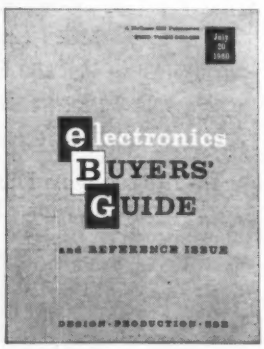

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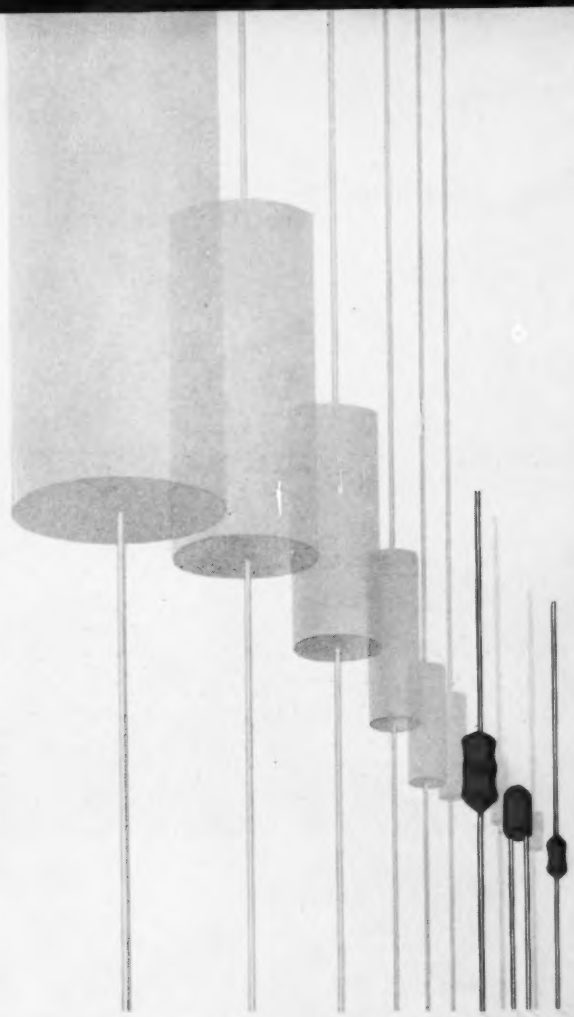

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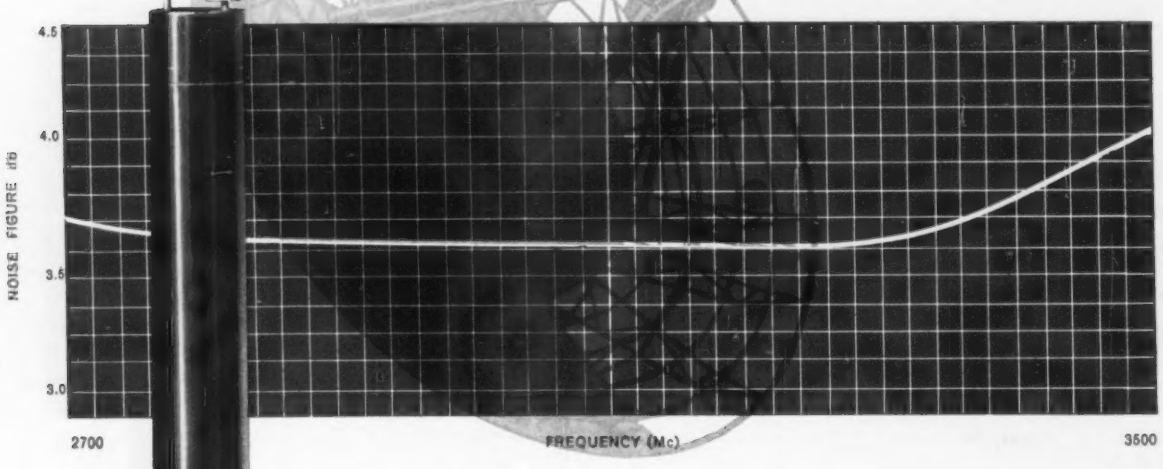

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